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Proton Irradiation of the Pituitary and Its Metabolic Effects

Memorial Fund Lecture¹

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It is a great pleasure to come to Chicago to discuss our investigations of the use of the proton beam in irradiation of the human pituitary gland, and I am indebted to the Radiological Society for this opportunity.

The work to be described here has been a cooperative effort, involving the time and talents of many people: The physicists, ably led by Professor C. A. Tobias; the cyclotron crew; the animal house staff, headed by Dr. Charles Riggs, and the Institute for Experimental Biology, who jointly performed the preliminary animal investigations; the medical section, directed by Dr. John H. Lawrence, assisted by Dr. James Born, Dr. James Roberts, and the late Dr. B. V. A. Low-Beer; the radiologists of Cowell Memorial Hospital who examined all the serial roentgenograms on our patients; the pathologists; the biochemists and technicians; and last, but by no means least, the physicians who referred us patients and gave us splendid cooperation in following them, notable among this number being Dr. Charles Huggins, whose encouragement and enthusiasm in the early phases of the work were invaluable.

Irradiation of the human pituitary gland by x-rays was reported by Gramegna in 1909, for the treatment of acromegaly

(1). Sensitivity of the skin and danger of injury to the brain and cranial nerves have limited the amount of radiation administered (2, 3). Nevertheless, roentgen irradiation has been a valuable therapeutic agent in pituitary tumors (4-7), malignant exophthalmos (8), and Cushing's syndrome (9). In recent years the pituitary has been irradiated also for prostatic (10) and mammary cancer (11).

Although experimental evidence suggests that overactive elements of the pituitary may be radiosensitive, statements in the literature seem to indicate that it is difficult, if not impossible, to influence the function of the normal pituitary by x-rays. Indeed, Crooke has stated that he has not observed histologic changes (12). In 3 reported cases of breast cancer, even 10,000 r to the region of the hypophysis was not sufficient to cause noticeable depression of hormone production, histologic damage, or remission of the disease (11).

Another means of delivering radiation to the hypophysis has been by a technic of radon-seed implantation; by this method pituitary function has been affected in Cushing's disease and acromegaly (13). More recently Rasmussen and associates have implanted in the pituitary yttrium

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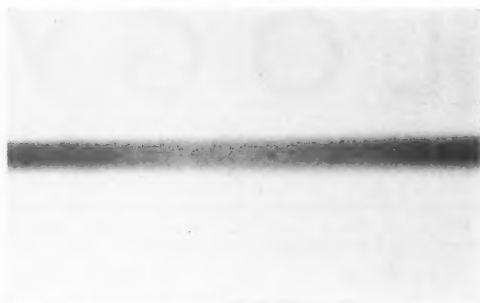


Fig. 1. Autoradiograph of the 340-MEV proton beam as it passes through a block of lucite.

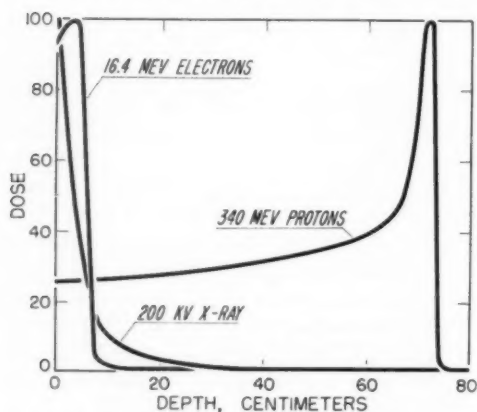


Fig. 2. Comparison of surface and depth doses for 200-kv x-rays, 16.4 MEV electrons, and 340 MEV protons in an absorber very similar to tissue.

seeds, giving sizeable doses of beta irradiation, to stop hypophyseal function and cause regression of breast cancer (14). This study is still in progress at the University of Chicago and at McGill University. Rothenberg and his colleagues instill colloidal chromic radiophosphate into the pituitary to effect its destruction (15).

Recent advances in surgical technic and postoperative management have made hypophysectomy feasible. Luft and Olivecrona, in Sweden, have reported their experience in some 37 cases of metastatic carcinoma of the breast (16) and in some 20 cases of severe diabetes mellitus (17). Kennedy and his associates at the University of Minnesota have reported 12 cases of breast cancer thus treated (18). Currently Pearson *et al.* (19) and other

groups are vigorously attacking the problems of hypophysectomy in cancer and other diseases.

The development of the cyclotron, betatron, linear accelerator, and other machines has made possible the production of beams of particles which may be directed to any

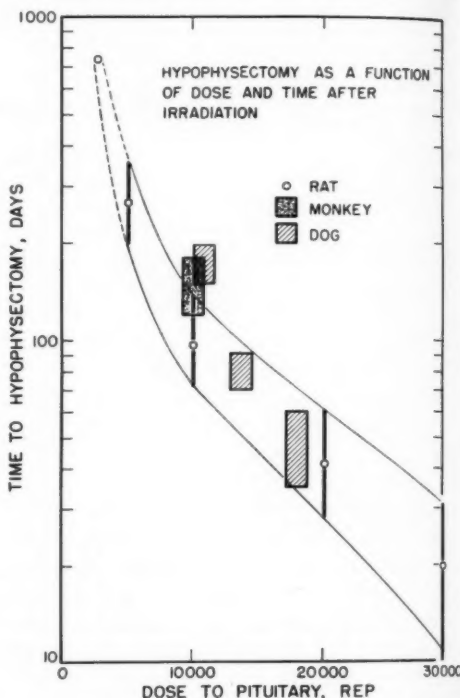


Fig. 3. Relationship between dose and time of onset of changes resembling hypophysectomy.

portion of the body. Our work has been with the 184-inch synchrocyclotron at the University of California in Berkeley; 190 MEV deuterons and 340 MEV protons were used in the preliminary animal studies, but only the 340 MEV protons have been used in work with human beings.

Deuteron and proton beams have several distinct properties not possessed by x-rays or gamma rays. First, they can be collimated very finely, and in small animals cylindrical lesions 1.0 mm. in diameter are easily produced (20). Secondly, as the particles penetrate, their scattering is so small (compared to electrons) that for practical purposes no

radiation falls outside the main beam to irradiate neighboring tissues. The lesions have microscopically sharp margins, much as might be made by scalpel. Figure 1 shows an autoradiograph of the 340 MEV proton beam as it travels along a piece of film sandwiched between two slabs of

obtained by rotational technic. Work is proceeding, however, in this direction.

Starting in 1952, efforts were made to study the effects of the high-speed particles on the rat hypophysis. Initial results were encouraging, and pituitary irradiation of monkeys, normal dogs, and dogs

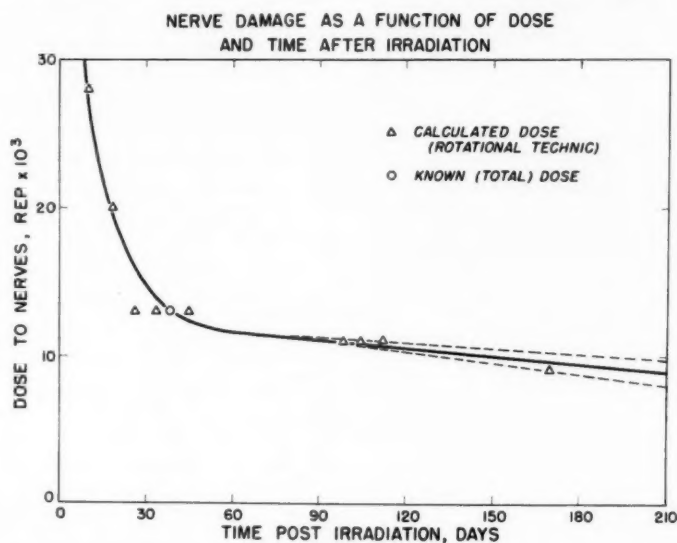
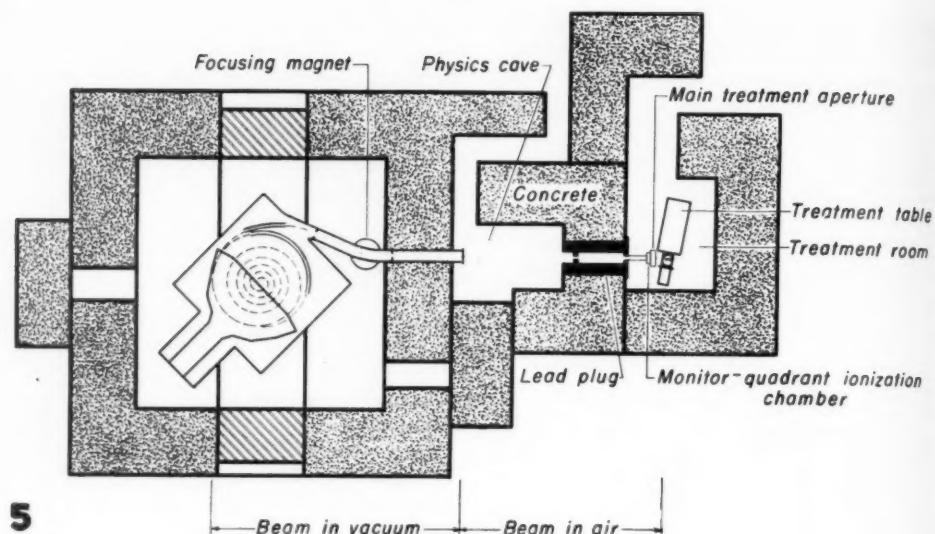


Fig. 4. Damage in dog cranial nerve as a function of dose and time after irradiation.

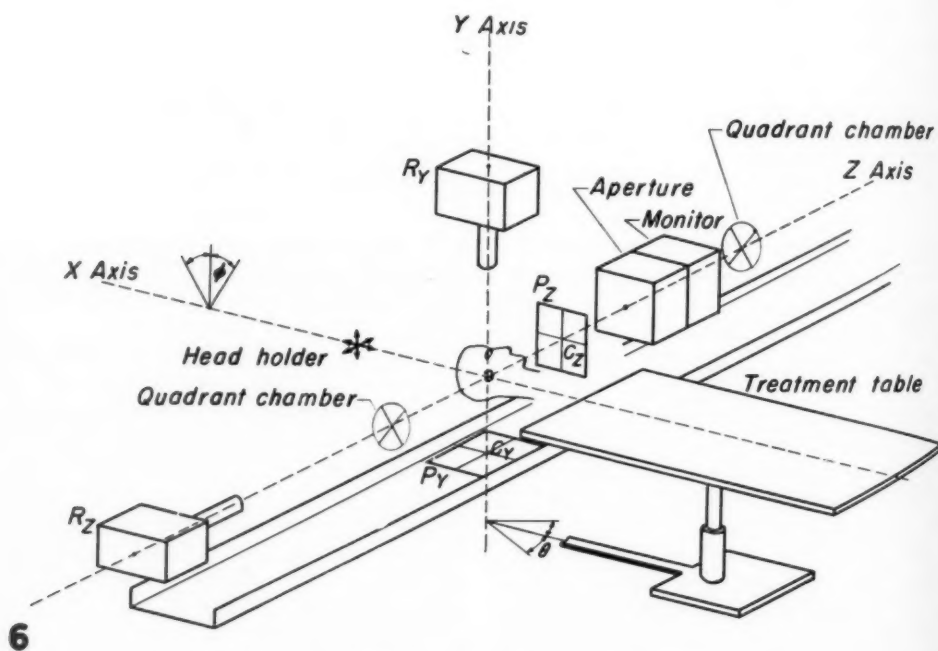
Lucite (21). The beam enters from the left. Part of the loss of definition on the right comes from the slightly divergent nature of the beam and part from multiple elastic scattering. A third unusual feature of these beams is the relatively great depth dose which they deliver, compared with surface dose. The comparative doses at the surface and depth for 200-kv x-rays, 16 MEV electrons, and 340 MEV protons are shown in Figure 2, after Tobias *et al.* (22). The dose delivered by the x-rays falls off markedly with increasing depth, as does that delivered by electrons from the betatron or synchrotron; but the proton irradiation rises to a peak, so that the maximum depth dose is approximately three times the dose at the surface. Up to the present time advantage has not been taken of this Bragg effect, and the relatively great depth doses are

with breast cancer was undertaken. The biological effectiveness of the high-energy deuteron and proton beams was found to be close to that of 200-kv x-rays.

When large single doses of more than 5,000 rad of deuterons or protons are given to the pituitary glands of animals, the final result appears to be the same regardless of the size of the dose. Progressive atrophy of the entire gland results, accompanied by reduction in physiological function. The higher the dose, the sooner the physiological effects become apparent. Single doses of 30,000 rad are necessary to approximate the immediate effects of surgical extirpation of the pituitary. Figure 3 shows the relationship between dose and the time of onset of profound physiological changes resembling complete hypophysectomy (21). Criteria for evaluation are chiefly rate of



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Fig. 5. Diagram of the synchrocyclotron, shielding, and treatment room.
Fig. 6. Schematic diagram of the apparatus for proton pituitary irradiation.

growth, thyroid function, and size of target organs. Data for rat, dog, and monkey follow the same general pattern.

Since May 1954, 51 dogs have received pituitary irradiation with protons or deuterons in various doses and by various

technics. Included were 36 normal beagles and 15 dogs with spontaneous mammary carcinoma.

Lethal effects of pituitary irradiation in large single doses in the normal dogs were ascribed to nerve and brain lesions, particularly to necrosis and hemorrhage. The lethal effects were usually preceded by damage to the 3rd, 4th, and 5th nerves, which, in the dog, lie very close to the pituitary. The lesions led to inability of the animals to move their eyelids, permanent dilatation of the pupils, and loss of corneal sensitivity. A series of experiments was performed to determine the dose-time relationship in the cranial nerves of the dog. The characteristic dose-time injury curve is shown in Figure 4, resembling the data for the pituitary (21).

A temporary type of nerve damage was also observed in some of the dogs; here the dose to the cranial nerves themselves was low, but the neighboring pituitary and cavernous venous plexus received heavy irradiation, in excess of 10,000 rad (21). Eye signs developed and increased in severity two to three weeks after irradiation, then partially or completely regressed six to eight weeks later. These signs were ascribed to pressure from edema of the nearby irradiated structures.

In the dogs with carcinoma, the results were favorable in animals initially in fair condition, *i.e.*, not terminal cases with necrosis. Persistence of some radioiodine uptake and continuation of estrous cycles showed that in these animals pituitary destruction was not complete. There were indications that the tumors may become static or regress, starting to grow again after a period of six to twenty-four months (23).

The stage was now set for proton irradiation of the human pituitary. Figure 5 shows the general layout of the apparatus (21). With the generous help of the staff of the Berkeley 184-inch cyclotron, a treatment room was constructed, as shown. The cyclotron is in the large shielded room at the left. The colli-

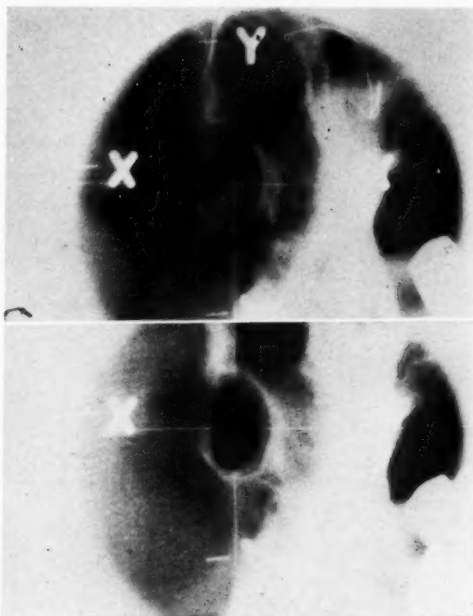


Fig. 7. Upper portion: Lateral roentgenogram of the sella turcica in correct alignment for proton irradiation. Lower portion: Same, except that the proton beam was turned on momentarily to make an autoradiograph.

mated proton beam is brought out through an aperture, passing through a physics cave into the treatment room, carefully shielded to avoid stray radiation.

During irradiation the patient is supine, the head held rigidly by a mask, which in turn is fastened to a head-rotating device. The set-up is shown schematically in Figure 6 (21). The proton beam passes along the Z axis from right to left. Quadrant chambers show any change in the position of the beam, and an ionization chamber in the path of the beam monitors the dosage. The beam is automatically shut off at any predetermined dose or if the head rotator fails or if the patient wishes to interrupt the seance for any reason. R_z is a diagnostic x-ray tube whose beam coincides with the proton beam. By its use lateral views of the sella turcica are made, the film being in the holder P_z . By means of adjusting screws on the head holder, the patient's head can be moved inferosuperiorly (along



Fig. 8. Anteroposterior roentgenogram of the sella turcica in correct alignment for proton pituitary irradiation.



Fig. 9. Patient in position for proton pituitary irradiation.

patient by momentarily turning on the proton beam, after making the x-ray exposure, prior to developing the film. The black spot shows the shape of the beam, which is adjusted to fit each individual patient. The beam spot is actual size, whereas the roentgen shadow of the sella is enlarged by 20 per cent because of divergence of the x-ray beam from the target spot.

R_Y is another diagnostic x-ray tube used to make anteroposterior views of the sella turcica. An adjusting screw on the head holder permits lateral movement of the patient's head (along the Z-axis) until the center of the sella turcica lies in the axis of rotation of the head (the X-axis). Figure 8 is a roentgenogram of

the X-axis) and anteroposteriorly (along the Y-axis) until the centers of the x-ray beam and proton beam pass through the center of the sella turcica. This is illustrated in the upper portion of Figure 7, which shows a head in position for treatment (21). A radioautograph of the proton beam, shown in the lower portion of the figure, was prepared for the same

a head in position for treatment (21). The medial margins of the orbits, the anterior clinoid processes, and the mid-point of the roof of the sphenoid sinus are useful in defining the mid-point of the sella turcica.

During the first irradiation seance, six to eight sets of diagnostic films were usually needed to bring the patient's

head into alignment. At subsequent sessions the adjusting screws on the head holder were pre-set to positions which had previously given proper alignment, and usually one or two sets of positioning roentgenograms sufficed.

Figure 9 shows a patient in position ready for pituitary irradiation (21). The proton beam will enter through the steel tube in the upper part of the picture.

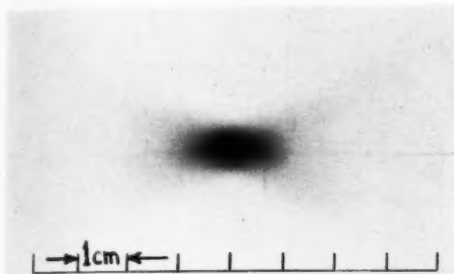


Fig. 10. Autoradiograph of the proton beam on a film placed at the site of the pituitary in a Lucite phantom cranium which was subjected to a complete schedule of rotations and position angles.

The fiberglass-and-plastic mask holds the head rigidly in the head rotator. The diagnostic x-ray sets used in alignment are shown on the left above and below.

Let us now return again to Figure 6 for further consideration of the irradiation technic. During the course of irradiation the patient's head was rotated slowly from side to side about the vertebral axis (X-axis); in most cases, unless disease in the cervical vertebrae prevented it, the rotation was 35° to either side ($\phi = 70^\circ$). The irradiation was, for the most part, administered in increments of 1,000 rad, each increment being delivered from a different direction by rotating the patient and treatment table (changing θ). By this means the beam was delivered in cones, all with apices in the sella turcica, ranging from 35° below to 35° above the coronal plane passing through the sella. In other words, the angle θ was varied through a total angle of 70° in eleven steps $7\frac{1}{2}^\circ$ apart.

In summary, the apparatus is contrived so that no matter how the patient's head

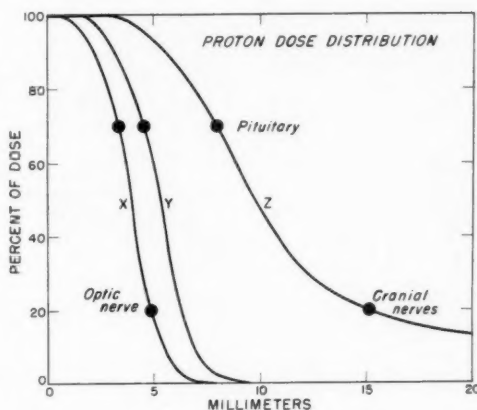


Fig. 11. Dose distribution, in terms of per cent of dose at the center of the pituitary, along the three major axes.

is turned the proton beam always passes through the sella turcica. The pituitary thus receives the greatest amount of radiation, while the dose delivered to structures removed from the pituitary varies inversely as the square of the distance.

Figure 10 is a radioautograph of the proton beam on a film placed in the Lucite head phantom and exposed to a full set of rotations and position angles corresponding to the entire irradiation schedule for the human being (21). The blackened area is the region of high dose and corresponds closely in size and shape to the human hypophysis.

Figure 11 shows the dose distribution along the three major axes of the head, X (longitudinal), Y (posteroanterior), and Z (lateral) (21). The data were obtained densitometrically from films placed in the Lucite phantom head at various distances from the pituitary in regions traversed by the proton beam. At the cranial nerves and temporal brain lobes the dose level is 10 to 20 per cent of the peak dose at the center of the hypophysis. Parts of the optic nerves receive 20 to 30 per cent of the peak dose, while most of the optic chiasm and hypothalamus are virtually free from irradiation.

The relationship between isodose curves and anatomical structures around the

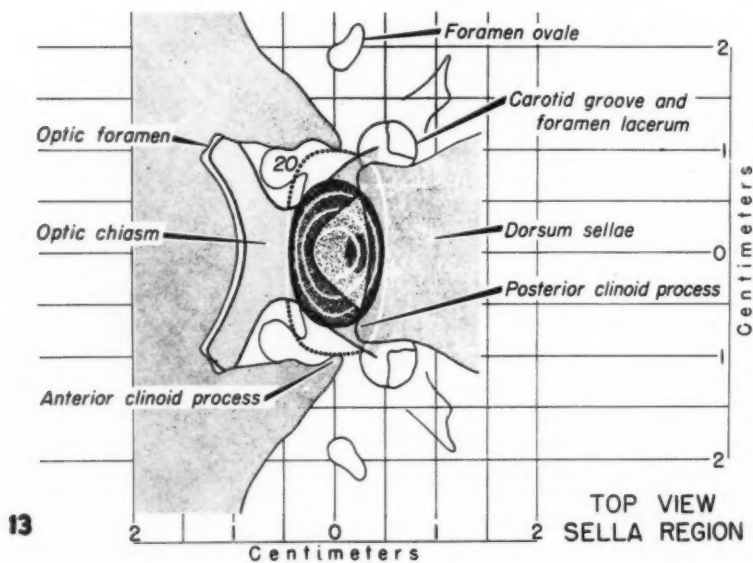
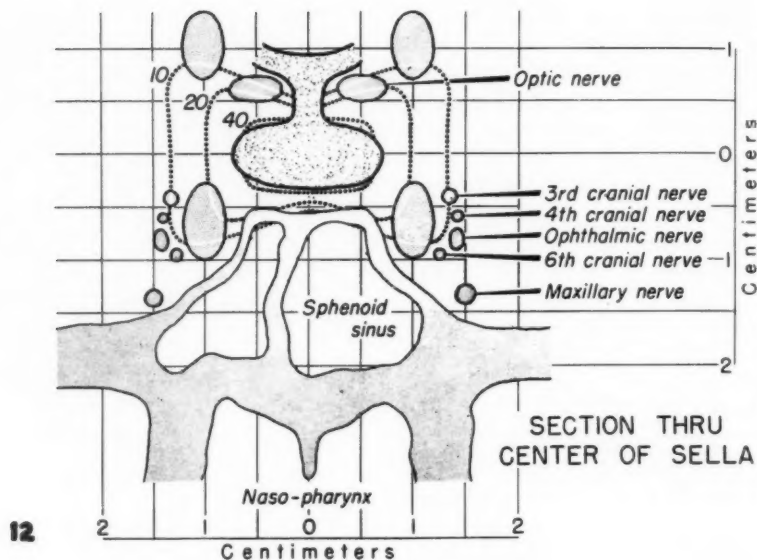


Fig. 12. Isodose curves plotted on a schematic diagram of a transverse section through the center of the sella turcica.

Fig. 13. Isodose curves plotted on a schematic diagram of a top view of the sella turcica. In both Fig. 12 and Fig. 13 the dose at the center of the sella turcica is taken as 100 per cent.

hypophysis is shown in Figure 12, which is a schematic drawing of a transverse section through the center of the sella. Figure 13 is a schematic drawing of the

sella as seen from above, with superimposed isodose curves (21).

Between September 1954 and September 1955, 26 patients with metastatic

breast cancer received pituitary irradiation. Patients were selected for irradiation on the basis of several criteria: (1) There must have been objective evidence of progressing metastases. (2) The patient should have received all indicated conventional surgical and radiological treatment. (3) Wherever practicable, the pa-

PITUITARY IRRADIATION SCHEDULE			
	Cumulative Total Rads	Irradiation Interval, Days	Rads per Session, Maximum
EARLY PATIENTS	14 000	63	650
LATE PATIENTS	30 000	14	5 000
			Rads per Plane, Maximum
			150
			1 000

Fig. 15. Irradiation schedule.

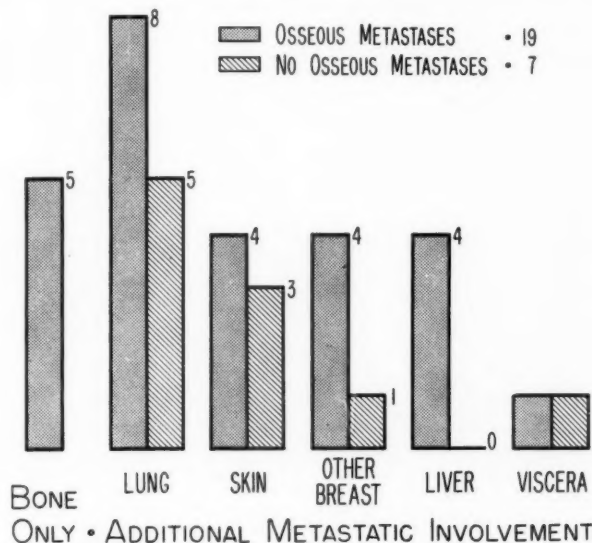


Fig. 14. Metastatic involvement of the patients when first seen.

tient should have received a trial of hormone therapy, adrenalectomy, and removal or roentgen irradiation of the ovaries. No patients were rejected because of the advanced state of their disease; many of the earlier cases were nearly terminal when first seen.

Sixteen patients, including the first 13 irradiated, had previously undergone bilateral adrenalectomy and oophorectomy, with remissions lasting from several months to several years. Of the other 10 patients, 3 had had only bilateral oophorectomy, and 7 had had neither adrenalectomy nor oophorectomy.

Nineteen of the patients had bone metastases; at least 8 of these had additional metastases in the lung and 4 had known metastases in the liver. The 7 patients without osseous involvement had

metastases in the skin, lungs, or viscera. Figure 14 summarizes the metastatic involvement for the series when the patients were first seen.

Proton irradiation of the pituitary was given in fractionated doses, three times weekly. The patients seen in the earlier period of the study received small doses per seance, and the course of irradiation covered a protracted period. As the work progressed and the safety factor could be evaluated, the amount of irradiation administered to the hypophysis and the cumulative total were increased, while the time required for the entire course of irradiation was shortened. Thus, the first patient received 14,000 rad during a sixty-three-day interval, while some of the later patients received as much as 30,000 rad in six seances within a two-

week period. Figure 15 summarizes the irradiation schedule.

Several patients complained of head pain following irradiation seances. This could be ascribed to manipulation of the neck during rotation or to pressure from the head mask. Neither during nor after

pituitary irradiation have been radioiodine uptake by the thyroid and twenty-four-hour urinary pituitary gonadotropin excretion. Figure 16 shows the changes in radioiodine uptake following pituitary irradiation. Of 18 patients for whom data are available, there was marked depression

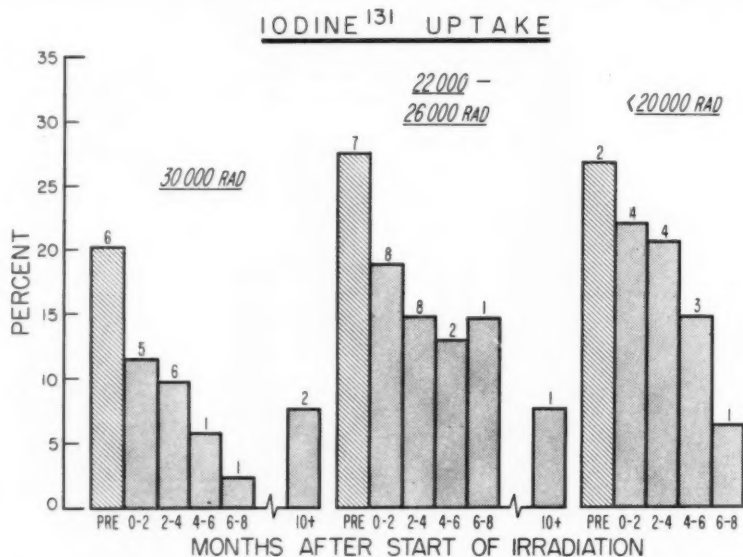


Fig. 16. Changes in twenty-four-hour thyroid radioiodine uptake following pituitary irradiation. The numeral above each column denotes the number of patients averaged in that group.

irradiation were any auditory, visual, or olfactory auras experienced. No indications of increased intracranial pressure, as manifested by papilledema, hyperthermia, vomiting, or vasomotor changes, were noted. No electrolyte disturbances were detected following irradiation sessions.

A few weeks following completion of irradiation, 5 patients, those receiving the heaviest irradiation, experienced severe head pains, lasting for a few days. They were usually described as throbbing, sharp, deep within the skull, and were relieved by aspirin. In all cases they soon disappeared completely. They resembled the headaches associated with acromegaly and other pituitary disorders.

The most valuable criteria for assessing changes in pituitary function following

of iodine uptake in 11, in many instances reaching values as low as 5 per cent. In 6 patients there was no significant change in radioiodine uptake, although in 4 of the 6 it was initially low. In one patient there was a slight rise. In 8 of 16 patients for whom complete data are available there was a marked drop in urinary excretion of pituitary gonadotropins. In 7 patients there was no change after irradiation, but in these the excretion was originally at the lowest concentration detectable, 5 mouse units. Only 1 patient showed a permanent rise. Figure 17 shows the changes in urinary gonadotropin excretion following irradiation.

In an effort to assess the state of activity of the disease, several laboratory tests were performed routinely—protein-bound iodine, alkaline and acid phosphatase,

urinary calcium excretion, coagulability of serum proteins, and urinary corticosteroid excretion. Details of these determinations will not be presented in this paper, which will be confined to clinical evaluation and the objective results of roentgen examination.

pigmentation, thinning of the eyebrows, absence of sweating, or loss of normal greasiness of the axilla, changes found by Sheehan and Summers in women with proved post-partum necrosis of the pituitary (24). The initial breast lesion in one patient changed markedly over a

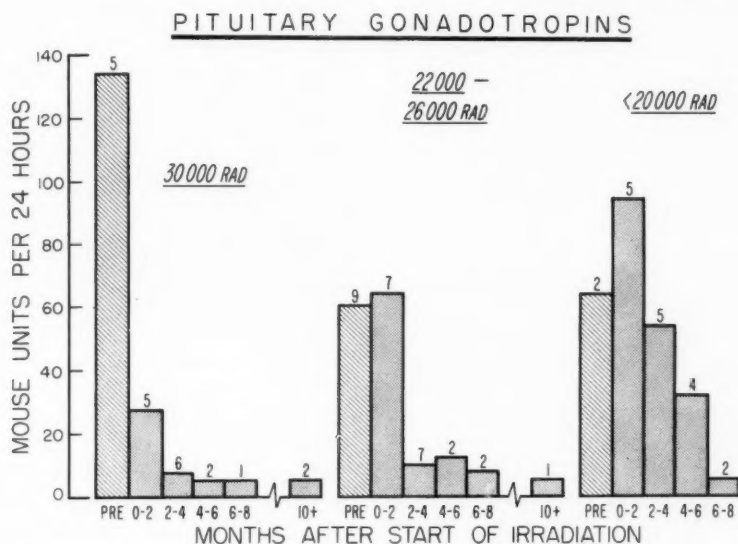


Fig. 17. Changes in twenty-four-hour urinary pituitary gonadotropin excretion following pituitary irradiation. The numeral above each column denotes the number of patients averaged in that group.

Serial skeletal and chest surveys were made regularly in all patients. Besides 5 patients who showed some healing of osseous lesions, there were 2 patients in whom the bony metastases remained stationary for several months. In one patient recurrent pleural effusion, with demonstrable tumor cells, resolved after irradiation and has not recurred in sixteen months. In 3 others, pulmonary metastases remained stationary for as long as a year after irradiation.

Clinical changes following pituitary irradiation included development in 3 patients of diabetes insipidus, which was managed satisfactorily by vasopressin tannate in oil, then by posterior pituitary principle nasal insufflation. The patients have not shown complete loss of pubic or axillary hair, absence of normal skin

period of several months in consistency and size, no longer being palpable. The affected portion of the breast became freely movable upon the underlying tissue. Biopsies, however, still disclosed the presence of tumor cells.

One patient with abdominal carcinomatosis had required, prior to irradiation, frequent paracenteses. During a surgical attempt at adrenalectomy and oophorectomy the intraabdominal metastases precluded this procedure, and she was selected for pituitary irradiation. At the time of starting irradiation, colloidal chromic radiophosphate was instilled into the peritoneal cavity, and the patient did not require paracentesis for over a year.

Upon the clinical appearance of the need for replacement therapy, the patients were given thyroid extract, 1 to



Fig. 18. Sagittal section of the pituitary gland from a patient who received 26,000 rad in twelve days and survived seven months.

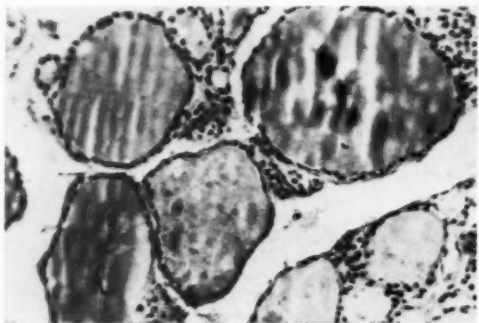


Fig. 19. Microscopic appearance of the thyroid gland in the patient of Fig. 18. This patient received no thyroid extract.

2 grains daily, and prednisolone, 10 to 15 milligrams daily, with satisfactory response. The adrenalectomized patients were, of course, continued uninterruptedly on a maintenance cortisone schedule. Several patients prior to irradiation had been placed on testosterone by their own physicians, and this was continued, primarily for its protein anabolic effect, since it had been unsuccessful in retarding metastatic extension.

Two patients now survive, both sixteen months post-irradiation. One is still in remission; the other had a remission for nearly a year and is now failing.

Twenty-two of the 24 deceased patients have come to necropsy. The effects of proton irradiation upon the pituitary and target organs will be discussed briefly.



Fig. 20. The sella turcica of a patient who received 30,000 rad in twenty-one days and survived fourteen months. (Photograph by Barry Evans, Berkeley, Calif.)

There was a marked difference in the pituitaries of patients who had received low (13,000 through 19,000 rad), medium (20,000 through 26,000 rad), and high (more than 27,000 rad) levels of irradiation. Damage was discernible grossly in those patients who received medium and high levels of irradiation and survived for, say, five months. Histologic evidence of damage was apparent in all patients who received over 20,000 rad, regardless of the interval between irradiation and death. Among those receiving less than 20,000 rad, microscopic examination showed necrosis infrequently; and the moderate fibrosis, increased vascularity, and shrinkage of cells from the basement membrane were not considered confirmatory of irradiation damage.

No gross evidence of injury has been detected in the brains or cranial nerves. Microscopic examination of the specimens is kindly being done by Dr. Nathan Malamud, Associate Clinical Professor of Neuropathology, Department of Pathology, University of California School of Medicine, San Francisco, but this is a

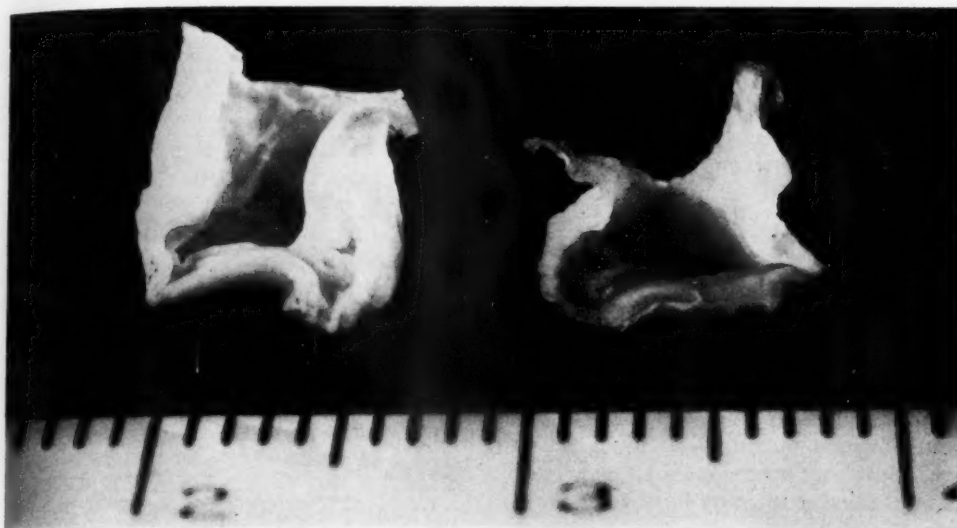


Fig. 21. The pituitary remnant dissected from the sella turcica of Fig. 20 and sectioned in the mid-sagittal plane (Photograph by Barry Evans, Berkeley, Calif.)

laborious task, and results of serial sections on all specimens are not yet available. Among the completed studies, including those on patients who had the highest levels of irradiation, there has been no evidence of irradiation damage to the brain or nerves.

Microscopic examination of the adrenal glands could lead to no definite conclusions because supportive corticosteroid therapy was given. Similarly, microscopic examination of the ovaries was not informative because of x-ray castration or the use of testosterone in the few patients with intact ovaries.

Microscopic examination of the thyroids showed involution at all levels of irradiation for all survival times. Several patients died without receiving thyroid extract.

To see just how well the proton beam can destroy the pituitary, reference may be made to Figure 18, which shows a sagittal section from a patient who received 26,000 rad in twelve days. Much of the center of the gland has been destroyed. Figure 19 shows the thyroid from this patient. Note that the acini are full of colloid, that there is no vacuoliza-

tion in the periphery of the colloid, and that the epithelium is flat. This patient did not receive thyroid extract.

The outstanding example of what has thus far been achieved with pituitary irradiation is illustrated by Figure 20, which shows the sella turcica of a patient who received 30,000 rad and survived fourteen months. There appears to be nothing whatever in the sella. Dissection produced only a 1.0-mm. thick sellar lining. This pituitary remnant, together with its investing membranes, is shown in Figure 21. The microscopic section is shown in Figure 22.

In conclusion, may I say that I have not come here as a proponent of destruction or extirpation of the pituitary gland in metastatic cancer. I believe that we have achieved our purpose. . . the destruction of a deep-seated organ without damage to the intervening tissues. I believe that some of our patients have been benefited and that we have demonstrated that we can depress pituitary function and destroy the pituitary without subjecting the patient to a craniotomy, with its mortality and morbidity. Whether or not hypophysectomy earns a lasting place

in the palliation of metastatic cancer—indeed, whether it is effective beyond adrenalectomy and oophorectomy—must await the combined test of the many workers now investigating the problem. I believe that our technic will be of value in the treatment of pituitary tumors, malignant exophthalmos, and, perhaps, Cushing's disease.

Ⓒ Rather, I come to you as a physicist turned doctor, to suggest that the technic and accelerating machines which have ushered in the nuclear era may, in a less cumbersome and less expensive form, become a part of the radiologist's therapeutic armamentarium, providing him with an agent of precision and penetrating power far exceeding any he now has.

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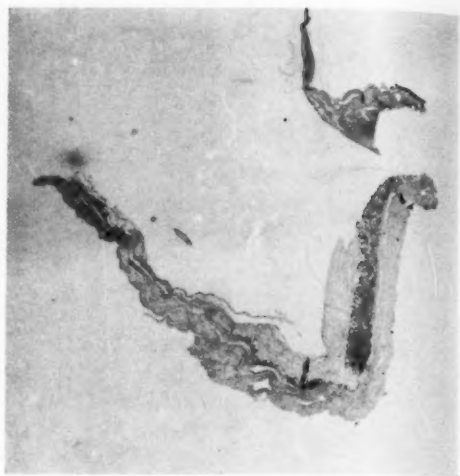


Fig. 22. Microscopic section, sagittal plane just off the mid-line, of the pituitary remnant shown in Fig. 21.

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SUMMARIO IN INTERLINGUA

Irradiation a Protones del Glandula Pituitari e Su Effectos Metabolic

Post experimentos in rattos e canes, irradiation a protones del glandula pituitari esseva executate in humanos. Inter septembre 1954 e 1955, 26 patientes con cancro avantiante del pectore recipeva irradiation pituitari a protones. Omne le patientes monstrava metastases progressive, e omnes habeva previemente essite tractate per medios conventional. Le irradiation esseva applicate in doses fractional con totales de 14.000 a 30.000 rad.

Duo patientes viveva post 16 menses: le un in remission e le altere con recurrentia de symptommas post un anno.

Evidentia histologic de un lesion del glandula pituitari esseva constatate al autopsia in omne le patientes qui habeva

recipite plus que 20.000 rad. Nulle macroscopic lesiones del cerebro o del nervos cranial esseva detegite. Le thyroides monstrava involution a omne nivellos de dosage.

Durante que destruction o extirpation del glandula pituitari non es recommendate super le base de iste studio como tractamento de cancro metastatic, il ha essite demonstrate que un organo de sito profonde pote esser destruite per irradiation a protones sin insulto a tessuto intermediari. Il pare que certes del patientes ha beneficiate del manovra, e le function pituitari esseva deprimite sin le necessitate de craniotomia con su associate morbiditate e mortalitate.



Radiologic Aspects of Operable Heart Disease

III. The Hazards of Retrograde Thoracic Aortography: A Survey¹

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THE USEFULNESS of retrograde thoracic aortography as a diagnostic adjunct in operable cardiovascular lesions has frequently been stressed (2-4, 11, 17, 23, 24). The hazards of this procedure have been incompletely explored in the past, although a number of deaths and serious reactions have been attributed to it (3, 12, 14, 16, 18, 20, 22, 25, 28, 29, 31-35). It seemed worthwhile, therefore, to attempt to arrive at some reasonable estimate of the dangers of retrograde thoracic aortography as performed in many centers throughout the world, in an effort: (a) to provide a frame of reference in which the potential value of the information to be gained might be balanced against the risk, and (b) to determine which technic seemed safest, and what safeguards might be employed to minimize the risk.

METHODS AND MATERIAL

Questionnaires were sent to 170 institutions in the United States, Canada, England, France, Sweden, Denmark, Germany, and South America, requesting information as to the site of injection, the type, concentration, and volume of medium used, premedication and anesthesia, reactions, and the indications for the procedure. A special data sheet for noting all factors involved in deaths following thoracic aortography was included.

RESULTS

1. *The Response:* Responses were forthcoming from 104 of the 170 institutions circularized. Of these, 59 answered yes to the question, "Do you perform retrograde thoracic aortograms?" Forty-one

of these 59 supplied sufficient data to be subjected to analysis.

2. *Death in Thoracic Aortography (Tables I-V):* Twenty-nine deaths were reported in a total series of 1,706 thoracic aortograms. This represents a mortality of 1.7 per cent and includes all types and concentrations of media and sites of injection.

A. *The Contrast Agent:* The concentration of the medium employed was a significant factor (Tables II and III). In 370 cases in which a 30 per cent or 35 per cent concentration of the medium was used there was only 1 death, contrasted with 24 deaths in 1,162 cases in which a 70 per cent concentration was employed.² The death rate with the more highly concentrated media was thus about eight times as high as with lower concentrations.

No conclusive statements can be made about the effect of total dosage. It is of interest, however, that in 11 of the 29 fatal cases two or more injections of the opaque medium were employed. Inspection of Table I reveals that many of the deaths followed the use of a high total dose, and this was also true of some of the severe non-fatal reactions.

No inferences can be drawn regarding the relative safety of media of different chemical composition. For the bulk of the aortograms either Urokon or Diodrast was used, and there was a slightly higher death rate among the 368 cases in which Urokon was used than in the 1,229 in which Diodrast was employed. (Seventeen deaths followed the use of Diodrast, a mortality of 1.4 per cent; 7 followed the use of Urokon, 1.9 per cent.)

¹ From the Department of Radiology, Stanford University School of Medicine, San Francisco, Calif. Presented at the Forty-second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2-7, 1956.

² The literature records an additional retrograde aortographic death purportedly associated with the use of a 35 per cent medium (29). This case was reviewed, and it was found that, in fact, 70 per cent Diodrast had been employed (30).

TABLE 1: DEATH IN THORACIC AORTOGRAPHY

Case No.	Age	Diagnosis and Autopsy Findings	Site of Injection	Medium	Per Cent Concentration	Dose/Injection	No. Injections	Total Dose	Anesthesia	Condition of Patient	Mode of Death	Remarks
1	3 mo.	Tetralogy of Fallot. Autopsy not helpful as to cause of death	Brachial artery	Diodrast	70	5 c.c.	2	10 c.c.	General	Poor	Cyanosis and dyspnea; respiratory death	Two injections
2	Infant	"Severe congenital heart disease"	Brachial artery	Urokon	70	3-6 c.c.	1	..	General	Poor	Anuria; death in renal and heart failure	
3	3 mo.	Large ventricular septal defect. Autopsy failed to show cause of death	Brachial artery	Urokon	70	10 c.c.	2	20 c.c.	Ether	Poor	Convulsions, apnea, cardiac arrest. Chest opened, heart massaged, cardiac action returned. Death 4 hr. later in coma	70 per cent Urokon used by error. Dose high. Two injections
4	56 yr.	Question of syphilitic aortitis. None at autopsy, which was unrevealing as to cause of death	Brachial artery	Diodrast	70	45 c.c.	1	45 c.c.	Local	Good	Spastic contractions of left side, aplasia, coma, generalized convulsions; death 8 hr. later	
5	2 yr.	Coarctation of aorta and patent ductus arteriosus. Autopsy showed "cerebral damage"	Carotid artery	Diodrast	70	20 c.c.	1	20 c.c.	Pentothal	Fair	Respiratory arrest after injection; temp. 105°. Extremities became flaccid and lungs filled with rales. Death a few hours later	Dose high
6	1 mo.	Ventricular and atrial septal defects	Carotid artery	Urokon	30	8 c.c.	2	16 c.c.	Ether	Poor	Increasing congestive heart failure; death 24 hours later	High total dose
7	Infant	"Severe congenital cardiac anomaly"	Carotid artery	Urokon	70	..	1	..	General	Poor	.....	Exact dose not known
8	Infant	"Severe congenital cardiac anomaly"	Carotid artery	Diodrast	70	..	2	..	General	Poor	Sudden death after second injection	Exact dose not known
9	Infant	"Severe congenital cardiac anomaly"	Carotid artery	Diodrast	70	..	1	..	General	Poor	Possibly anesthetic death	Exact dose not known
10	5 wk.	Endocardial fibroelastosis. Autopsy showed cerebral edema	Carotid artery	Hypaque	90	10 c.c.	2	20 c.c.	Local	Poor	Death shortly after second injection; probably cerebral	High total dose

TABLE 1: DEATH IN THORACIC AORTOGRAPHY—*cont.*

Case No.	Age	Diagnosis and Autopsy Findings	Site of Injection	Medium	Per Cent Concentration	Dose/Injection	No. Injections	Total Dose	Anesthesia	Condition of Patient	Mode of Death	Remarks
11	Below 1 yr.	Cyanotic congenital heart disease	Carotid artery	Urokon	70	..	2	..	Ether	Poor	These four infants were said to have died of combined cardiac and respiratory failure	Exact dose unknown. All 4 patients had angiograms just prior to aortograms, considered as "first" injection
12	Below 1 yr.	Cyanotic congenital heart disease	Carotid artery	Urokon	70	..	2	..	Ether	Poor		
13	Below 1 yr.	Cyanotic congenital heart disease	Carotid artery	Diodrast	70	..	2	..	Ether	Poor		
14	Below 1 yr.	Cyanotic congenital heart disease	Carotid artery	Diodrast	70	..	2	..	Ether	Poor		
15	2 wk.	Coarctation of the aorta and patent ductus arteriosus	Carotid artery	Diodrast	70	4 c.c.	1	4 c.c.	General	Poor	Apnea shortly after injection; failure to recover	
16	74 yr.	Terminal multiple myeloma	Catheter in aorta via brachial artery	Neo-Iopax	75	10 c.c.	6	60 c.c.	Local	Poor	Unknown	Attempt to show coronary arteries. High total dose
17	88 yr.	Coronary arteriosclerosis. Cerebrovascular hemorrhage	Catheter in aorta via brachial artery	Diodrast	70	12 c.c.	5	60 c.c.	Local	Poor	Arrhythmia during procedure; death thought to be due to cerebral damage	High total dose
18	45 yr.	Mediastinal tumor	Catheter in aorta via brachial artery	Diodrast	70	30 c.c.	1	30 c.c.	Local	Good	Following injection, unconsciousness and hemiplegia; death in 3 days	Catheter tip in innominate artery by error. Most of Diodrast went directly into carotid artery
19	46 yr.	Mediastinal tumor	Catheter in aorta via brachial artery	Diodrast	70	24 c.c.	1	24 c.c.	Local	Good	Immediate unconsciousness and hemiplegia; death in 2 days	Error in technique, with catheter tip in innominate artery at time of injection. Most of Diodrast entered carotid artery
20	30 yr.	Coarctation of aorta	Catheter in aorta via radial artery	Diodrast	70	85 c.c. 35 c.c.	1 1 (1 wk. later)	85 c.c. 35 c.c.	Pentothal	Good	Renal insufficiency; death in renal failure	Interval of 1 week between 1st and 2nd aortograms. First injection in ascending aorta, 2nd in descending aorta below site of coarctation
21	20 yr.	Coarctation of aorta	Catheter in aorta						Local	Good	Sudden death following introduction of cath.	No injection. Cause of death unknown. Cath.

21	20 yr.	Coarctation of aorta	Catheter in aorta via radial artery	..	..	..	..	..	Local	Good	Sudden death following introduction of catheter into ascending aorta via radial artery	No injection. Cause of death unknown. Catheter non-opaque. May have entered coronary artery
22	36 yr.	Truncus arteriosus. Autopsy showed multiple acute hemorrhagic foci in the brain	Catheter in aorta via brachial artery	Diodrast	70	22 c.c.	1	22 c.c.	Local	Poor	Immediate convulsions, coma, respiratory failure, cyanosis; death in 4 hours	Catheter tip in origin of left common carotid artery
23	4 mo.	Arterioventricular communication and coarctation of aorta	Catheter in aorta via carotid artery	..	..	..	..	..	Local	Poor	Hemorrhage and shock	Catheter inserted into carotid artery with difficulty under fluoroscopy; became looped in common carotid artery, while lights out during fluoroscopy. Sudden massive hemorrhage; death in 4 hours despite efforts to combat shock
24	..	Aneurysm of aorta. Autopsy unrevealing	Catheter in aorta via carotid artery	Diodrast	70	35 c.c.	1	35 c.c.	General	Fair	Immediate collapse and death after aortography	Anesthetic death?
25	..	Aneurysm of aorta. Autopsy unrevealing	Catheter in aorta via carotid artery	Diodrast	70	35 c.c.	1	35 c.c.	General	Fair	Failure to come out of anesthesia; death 8 hours later	.....
26	Child	Congenital heart disease	Catheter in aorta via femoral artery	Urokon	70	..	..	..	General	Fair	Cardiac arrest and death following aortography under general anesthesia. Cause not apparent	.....
27	47 yr.	High aortic obstruction?	Catheter in aorta via femoral artery	Diodrast	50	..	..	..	General	Fair	Convulsions; hemiplegia; death 2 days later	Possibility that catheter dislodged thrombus
28	67 yr.	Innominate artery aneurysm. Severe hypertension. At autopsy right cerebral hemisphere was soft and necrotic	Catheter in aorta via carotid artery	Hypaque	50	50 c.c.	1	50 c.c.	Local	Fair	Immediate headache and sweating; mental confusion during next few days; death in 1 week	Catheter tip in innominate artery aneurysm when injection was performed
29	66 yr.	Thyroid tumor. Autopsy unrevealing as to cause of death	Direct needle puncture of aortic arch	Diodrast	70	30 c.c.	1	30 c.c.	General	Fair	Rapid, feeble pulse immediately after injection; fall in blood pressure; death on following day	Sustained opacification of coronary arteries; it was thought that coronary ischemia might be cause of death. EKG not satisfactorily evaluated because of heart rate of 200

TABLE II: THORACIC AORTOGRAPHY. ROUTE OF INJECTION, MEDIUM, AND DEATHS

Medium	Brachial* Artery		Carotid Artery		Catheter in Aorta		Direct Aortic Puncture		Total	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Diodrast 35%	287	..	26	..	..	..	..	..	313	0
Diodrast 50%	8	..	..	..	26	1	..	..	34	1
Diodrast 70%	30	2	121	6	723	7	8	1	882	16
Urokon 30%	28	..	21	1	..	..	..	..	49	1
Urokon 40%	40	..	..	..	4	..	..	..	44	0
Urokon 50%	..	..	..	..	12	..	..	..	12	0
Urokon 70%	78	2	38	3	147	1	..	..	263	6
Neo-Iopax 30%	5	..	..	..	3	..	..	..	8	0
Neo-Iopax 75%	2	..	1	..	12	1	..	..	15	1
Hypaque 50%	33	..	..	..	6	1	..	..	39	1
Hypaque 90%	..	..	2	1	..	..	..	..	2	1
Renografin	10	..	1	..	32	..	..	..	43	0
No injection	..	..	..	..	2	2	..	..	2	2
TOTAL	521	4	210	11	967	13	8	1	1706	29

* Seventy-three of the cases listed under Brachial Artery were actually counter-current ulnar or radial artery injections. There were no deaths in this group.

TABLE III: THORACIC AORTOGRAPHY. CONCENTRATION OF MEDIA AND DEATH

Concentration	Number of Cases	Number of Deaths	Mortality
30%-35%	370	1	0.027%
50%	128	2	1.60%
70% or higher	1162	24	2.07%

B. The Site of Injection:³ Reference to Table IV suggests that injection directly into the carotid artery increases the hazard. In such cases the mortality rate was higher than when brachial artery or catheter injections were utilized. The group of brachial artery injections is not entirely comparable with the carotid artery injections because it includes more studies with media of lower concentration. When direct carotid and catheter injections of com-

³ By brachial artery injection is meant the direct counter-current injection of the opaque medium into the brachial artery with sufficient force so that it reaches and opacifies the thoracic aorta. Carotid artery injection refers to the direct counter-current injection of the opaque medium into the carotid artery so that it reaches and opacifies the thoracic aorta. Catheter injection refers to the injection of the opaque medium through a catheter threaded into the thoracic aorta via the radial, ulnar, brachial, carotid, or femoral artery. (One hundred twenty of 967 catheter injections were done with the catheter inserted in the femoral artery and threaded cephalad in the aorta. In the bulk of the remaining catheter injections, the sites of insertion of the catheter were the radial, ulnar, and brachial arteries, with a relatively small percentage inserted through the carotid artery.) A group of 8 injections were made by direct puncture, i.e., the needle was inserted directly into the aortic arch from an anterior approach.

parable media are compared (Table V), the mortality rate following carotid injection is significantly higher.

C. Premedication and Anesthesia: About three-fourths of the procedures were performed under general anesthesia. Open-drop ether or intravenous Pentothal were the preferred agents. Premedication given to those patients examined under local anesthesia usually included a combination of barbiturates and morphine, or barbiturates and Demerol. A number of workers routinely employed small doses of scopolamine or atropine.

The data failed to support the idea that the use of general anesthesia augments the danger of the procedure. On the other hand, a number of the comments suggested that death was due to general anesthesia. Furthermore, the group of deaths occurring with local anesthesia was weighted by 2 cases in which the patient died prior to the injection of any medium (Cases 21 and 23), 2 instances in which the patients were

TABLE IV: THORACIC AORTOGRAPHY. ROUTE OF INJECTION AND DEATH

Route	Number of Cases	Number of Deaths	Mortality
Brachial artery	521	4	0.71%
Catheter in aorta	967	13	1.35%
Carotid artery	210	11	5.24%
Direct puncture	8	1	..
TOTAL	1706	29	1.70%

TABLE V: COMPARISON OF CATHETER AND CAROTID INJECTION OF COMPARABLE MEDIA

Medium	Carotid Artery			Catheter in Aorta		
	No. Cases	No. Deaths	Mortality	No. Cases	No. Deaths	Mortality
Diodrast 70%	121	6	5%	723	7	1%
Urokon 70%	38	3	8%	147	1	0.7%

moribund to begin with (Cases 16 and 17), and 3 instances in which most of the medium was injected by error into the innominate or common carotid artery (Cases 18, 19 and 22).

D. Age: No clear cut influence of age on the risk involved was apparent. About one-fourth of the examinations each were in the age group below one year, from one to ten years, from eleven to twenty years, and over twenty years. About two-thirds of the brachial artery injections were in patients less than a year old, while most of the carotid artery injections were in patients below the age of 5. Conversely, two-thirds of the patients receiving catheter injections were above the age of eleven. Virtually all deaths in the younger groups occurred under the age of one. Deaths in the older groups were usually in patients past twenty. Between these two groups was a rather large hiatus in which a considerable number of examinations were performed with relatively few deaths.

E. Condition of the patient: As can be seen from Table I, about two-thirds of the patients who died were in poor condition at the time of the procedure. A number, however, were in either fair or good condition. Without knowing the exact status of all patients in whom the procedure was performed without reaction, no comparison of death rates can be made in this regard.

F. Mode of Death: Among those cases in which the factors responsible for death seemed most clear, brain damage and the complications thereof were noted in 9, the largest single group among the deaths. In these patients, convulsions, hemiplegia, aphasia, and coma developed and death occurred in hours to days. Among the pathologic findings described in these cases were cerebral edema, cerebral "damage," acute hemorrhagic foci in the brain and

cerebral necrosis. In the 3 instances in which a clear-cut respiratory death occurred, there seems a reasonable likelihood that this may have been due to medullary damage following the injection of the opaque medium. In these cases, an initial respiratory apnea was sustained, without subsequent recovery. In 2 cases, death was attributed to heart failure, and in 2 to renal involvement with the subsequent development of anuria and renal failure. In 3 instances, the question of an anesthetic fatality was raised, but the mode of death must be considered uncertain. In 1 case, death certainly occurred from hemorrhage, and in another from shock, and 4 patients were said to have died from a combination of respiratory and cardiac failure.

Two deaths in the catheter group occurred prior to injection. In 1 the catheter was thought to have lodged in a coronary artery, and in the second there was profuse hemorrhage about the site of insertion, followed by the development of shock and death. The position of the catheter in the innominate or carotid artery was thought to play a significant role in 4 other deaths. Thus, technical factors relating to the positioning of the catheter apparently contributed to at least 6 of the 13 catheter fatalities.

3. *Severe Non-Fatal Reactions* (Table VI): A. *Hemiplegia*, with gradual return of function in a few days to a few months, developed in 13 patients. In 11 of these, a 70 per cent concentration of the contrast agent was employed; in 2, a 50 per cent concentration. In a number of instances the total dose was large. The injection route was *via* a catheter in the aorta in 8 and directly into the carotid artery in 4. In a few instances, some residual evidence of the hemiplegia remained over a long period of time.

TABLE VI: THORACIC AORTOGRAPHY. SEVERE NON-FATAL REACTIONS

Case No.	Age	Site of Injection	Medium	Per Cent Concentration	Nature of Reaction	Comments
1	7 yr.	Carotid artery	Diodrast	70	Hemiplegia	Gradual return of function after many months
2	Child	Carotid artery	Urokon	70	Hemiplegia	Complete recovery
3	Adult	Carotid artery	Diodrast	70	Hemiplegia	Recovery after several weeks
4	..	.....	Diodrast	70	Hemiplegia	Slow recovery
5	Adult	Catheter in aorta via brachial artery	Diodrast	70	Hemiplegia	Temporary
6	8 yr.	Catheter in aorta via carotid artery	Diodrast	50	Hemiplegia	Transient
7	47 yr.	Catheter in aorta via carotid artery	Diodrast	50	Hemiplegia	Transient
8	Adult	Carotid artery	Diodrast	70	Hemiplegia	Temporary
9	Adult	Catheter in aorta	Diodrast	70	Hemiplegia and convulsions	Transient
10	Adult	Catheter in aorta	Diodrast	70	Hemiplegia and convulsions	Transient
11	35 yr.	Catheter in aorta via femoral artery	Diodrast	70	Hemiplegia	Transient; 3 injections of 20 c.c. Diodrast had been used
12	54 yr.	Catheter in aorta via femoral artery	Diodrast	70	Hemiplegia	Transient; 4 injections totaling 110 c.c. of 70% Diodrast injected over 90-min. period. Catheter tip in innominate artery
13	Adult	Catheter in aorta via femoral artery	Urokon	70	Hemiplegia and convulsions	Cleared in several days. 200 c.c. of 70% Urokon used
14	Infant	Catheter in aorta via ulnar artery	Urokon	70	Convulsions and cyanosis	70% medium used by error. Recovery in 10 hours
15	Infant	Catheter in aorta via ulnar artery	Urokon	30	Convulsions, disorientation, blindness. Severe renal reaction with oliguria and uremia	Recovery in 10 days
16	Child	Catheter in aorta via brachial artery	Urokon	70	Convulsions	Rapid recovery. Catheter slipped into vertebral artery
17	..	Catheter in aorta via carotid artery	Urokon	50	Convulsions	Transient. Catheter tip in carotid artery
18	Adult	Catheter in aorta via brachial artery	Diodrast	70	Convulsions	Temporary
19	Child	Carotid artery	Urokon	30	Convulsions, severe apnea, arrhythmias	Recovery
20	Adult	Catheter in aorta via femoral artery	Urokon	70	Brown-Séquard syndrome	Cleared in two weeks. 55 c.c. of medium used.
21	Adult	Catheter in aorta via radial artery	Diodrast	70	Anuria	Recovery
22	Adult	Catheter in aorta via radial artery	Diodrast	70	Anuria	Recovery
23	Adult	Catheter in aorta via radial artery	Diodrast	70	Anuria	Recovery
24	Adult	Catheter in aorta via radial artery	Diodrast	70	Anuria	Recovery
25	Adult	Catheter in aorta	Diodrast	70	Oliguria, flank pain, fever, albuminuria	Recovery in a few days
26	Adult	Catheter in aorta	..	..	Dissecting aneurysm	Catheter became lodged above site of coarctation, causing chest pain. Fresh, small dissection shown at surgery

B. *Convulsions* were noted following the procedure in 6 cases. In 1 of these, disorientation and blindness accompanied the convulsions, in another severe apnea and arrhythmias, and in a third, rather marked but temporary cyanosis. No permanent sequelae were observed.

C. A severe *renal reaction* with anuria or oliguria was observed in 6 cases: 5 in which 70 per cent Diodrast and 1 in which 30 per cent Urokon was used. When recovery occurred, there was no evidence of residual renal damage.

D. Two other severe reactions deserve mention. In an adult patient with coarctation of the aorta, the tip of the catheter became lodged just above the site of the coarctation, at which time the patient complained of chest pain. When surgery for the coarctation was undertaken, a small dissection of the aorta was observed just above the site of narrowing, thought to have been initiated by the catheter tip. In 1 other patient, a Brown-Séquard syndrome developed, with gradual recovery after two weeks.

4. *Other Reactions:* A. *Cardiovascular:* Bradycardia was noted almost as frequently as tachycardia by most observers. Mild arrhythmias were observed in many cases, and among those who routinely employed continuous electrocardiography, electrocardiographic alterations of minor degree were not uncommon. Extrasystoles, T-wave changes, and nodal rhythm were recorded. Changes were prominent in patients with a large patent ductus arteriosus. Moderate lowering of blood pressure was described, and in a few instances a temporary shock-like state was reported.

B. *Respiratory:* Although short periods of apnea sometimes followed injection, hyperpnea was more commonly observed. In a small number of cases, Cheyne-Stokes respirations were reported. Cough was a common reaction, especially in the presence of patent ductus arteriosus.

C. *Cerebral:* Syncope and mental confusion, when they occurred, were usually associated with a major non-fatal reaction.

Those instances in which convulsions and hemiplegia occurred are considered under the major non-fatal reactions.

D. *Miscellaneous:* Vomiting followed aortography in some cases, but was usually associated with general anesthesia. Delayed allergic reactions, with pruritus and fever, were noted occasionally. In 1 case a temporary brachial plexus palsy followed the procedure. In another, an inflammatory reaction occurred in an arteriovenous malformation about the shoulder. Gangrene of 4 fingers of the right hand following brachial artery catheterization was reported in 1 adult. There were 2 instances of ischemia of the hand after radial artery catheterization, both of which improved over a period of months. A single report of appearance of the medium in the superior vena cava following brachial artery catheterization and injection indicated that a small rupture in the artery had occurred. This was substantiated by the appearance of a hematoma, but no permanent arteriovenous fistula resulted. One description of a post-aortographic reaction resembling mesenteric thrombosis was included, and a case of rather severe laryngospasm was also noted.

5. *The Maximum Number of Injections:* In about half of the responding institutions, one injection was considered the maximum for each procedure. Most of the remaining replies indicated that 2 injections were permissible. Four observers thought that more than 2 were safe if the patient was in good shape. No correlation between the number of deaths at a particular institution and its practice in this respect could be ascertained.

6. *Recommended Dosage:* A large variety of dosage schedules were submitted, most of which fit into the following range: 0.5 to 1 c.c. per pound of body weight for the 30-50 per cent media in infants and children, and 0.25 to 0.33 c.c. per pound for 70 per cent media in adults.

7. *Continuous Electrocardiography:* Only one quarter of those performing thoracic aortography used continuous electrocardiography, and some felt it was quite

unnecessary. One observer stated: "It makes no difference whether blood stops moving because of ventricular standstill or ventricular fibrillation. In either event, I would open the chest immediately. Why then delay the procedure with the electrocardiogram?" Another wrote: "Electrocardiographic tracings are desirable but probably will not foretell a catastrophe." Still a third felt that they were of considerable importance in forewarning of an impending general reaction, and that electrocardiographic changes might precede, if only by a short time, severe symptomatic manifestations, particularly in patients under general anesthesia.

DISCUSSION

The indications for retrograde thoracic aortography vary in different institutions. By those who replied to the questionnaire, aortography was considered most rewarding in the detection of patent ductus arteriosus as a cause of heart failure in infancy, in delineating coarctation of the aorta in infants with heart failure, and in differentiating patent ductus arteriosus from aortic septal defects (here it is important that the catheter technic be employed, in order to opacify the root of the aorta). Aneurysm of the thoracic aorta, prior to surgical repair, aneurysm of the sinus of Valsalva with fistula into the right ventricle, bizarre anomalies of the aortic arch, and, in some instances, coarctation of the aorta in children and adults (especially in unusual sites) were thought to warrant aortographic study, although many considered special studies unnecessary in coarctation. In patent ductus arteriosus in older children and adults, cardiac catheterization was felt by most observers to give more information. Other indications mentioned by some respondents included the tetralogy of Fallot with pulmonary atresia, for demonstration of the vascular supply to the lung; truncus arteriosus, for determination of the origin of the pulmonary arteries; coarctation, postoperatively, in order to show the site

of repair; arteriovenous fistula of the great arteries of the aortic arch, pulseless disease, dissecting aneurysm, aortic insufficiency, and visualization of the coronary arteries.

Since retrograde thoracic aortography, like all procedures involving the intravascular injection of contrast media (27), has a significant morbidity and mortality, this risk must be weighed against the usefulness of the information to be derived in each instance. Unlike angiocardiology, thoracic aortography is unlikely to exert a direct effect upon the heart and the lungs except in the presence of patent ductus arteriosus or following injection into the coronary arteries. Unless the injection is through a catheter adjacent to the sinuses of Valsalva, the opaque medium seldom reaches the coronary circulation in significant amounts, and, indeed, in the retrograde brachial injection, the root of the aorta is rarely opacified.

The fact that electrocardiographic changes follow thoracic aortography does not constitute evidence of a direct effect on the heart in these cases, since similar alterations are noted following encephalography (6), electric shock (21), and intracarotid Diodrast injection (19). Although some of the opaque medium eventually reaches the lungs after transit through the brain and right heart, it is too dilute to produce significant or direct respiratory reactions, and these reactions are therefore probably mediated by the medullary respiratory centers. That the brain is the major center of post-aortographic reactions is corroborated by study not only of the deaths, but also of the severe non-fatal reactions, in which convulsions and hemiplegias predominate.

The knowledge that all of the iodinated contrast media in general use are capable of producing profound cerebral damage is not new. Broman and Olsson have demonstrated that breakdown of the blood-brain barrier occurs following the injection of Diodrast into the carotid artery and that respiratory paralysis may develop (9). They also noted that edema and punctate

hemorrhages were visible histologically if the dosage of Diodrast was high enough (8, 10). They have pointed out that the severity of the disturbance of permeability is related to the concentration of the medium and to the duration of its action, that the injury is reversible if slight, and that pre-existing cerebral tissue changes increase the risk of disturbing cerebral vascular permeability (26). Their findings have been amply confirmed in subsequent investigations (5, 7, 15, 19) and in clinical studies (1, 13).

A thorough appreciation of the cerebral effects of the contrast agents is integral to any approach which attempts to diminish severe reactions. In contrast to angiocardiology, in which the opaque medium usually becomes diluted in the heart and lungs before reaching the brain, the medium in thoracic aortography may enter the carotid arteries and the cerebral circulation in relatively concentrated form. It most closely approximates the conditions in cyanotic congenital heart disease with right-to-left shunt into an overriding or transposed aorta; and it is hardly coincidental that the highest mortality in angiocardiology is among infants and children with cyanotic congenital cardiac anomalies!

There were 2 deaths and a number of severe non-fatal reactions caused by renal injury, and certainly the effect on the kidney is another serious consideration. Probably pre-existing renal damage with associated azotemia should be considered a contraindication to the performance of thoracic aortography.

The technical errors attendant upon catheter aortography have already been mentioned. The catheter should be in the mid-ascending aorta at the time of injection.

Finally, the role of general anesthesia as an additional hazard remains to be noted. In 3 instances, death was thought to be due to the general anesthetic. In spite of this, there is no objective evidence in the survey that general anesthesia augments the risk of thoracic aortography.

RECOMMENDATIONS

The following recommendations seem reasonably designed to diminish the risk of retrograde thoracic aortography:

1. *Carotid Compression:* This should be routinely employed during the injection period. A rectangular lead cape for the hands of the member of the team performing the compression can easily be constructed, or lead gloves with index-finger cut-outs may be applied. If carotid compression is effective, relatively little of the medium will reach the brain except through the vertebral arteries. These cannot be effectively compressed.

2. *Concentration of the Medium:* In infants and children under four, 70 per cent concentrations should not be employed. Diodrast 35 per cent and Hypaque 50 per cent are quite satisfactory, and the latter may be used in older children and small adults. For most adults, a 70 per cent concentration is required. Since the 70 per cent media are responsible for more deaths than the 35 per cent media, they must be used cautiously. No deaths are on record following the retrograde brachial injection of 30-35 per cent media.

3. *Dose of the Medium:* A dosage scale should be constructed in each institution based on the smallest volume consistent with a satisfactory examination. The practice of using huge amounts to insure opacification more dense than diagnostic considerations require is hardly sound. Sample dosage schedules have been published (3, 4, 24). In adults, 20 to 30 c.c. of a 70 per cent contrast agent should prove adequate for opacification of the thoracic aorta.

4. *Second Injections:* We have not hesitated to employ a second injection of 35 per cent Diodrast in infants and children when the first injection failed to yield a diagnostic examination. This should not be done if there has been a significant reaction to the first injection. In adults, it seems prudent to eliminate second injections of 70 per cent media when possible. Since repetition of the injection is more often than not necessitated by technical

failures, the technic should be carefully planned and all details considered *before* the first injection.

5. *Carotid Injection*: Direct counter-current injection through the carotid artery appears to increase the risk significantly and should be discontinued as a routine method of opacifying the aorta.

6. *General vs. Local Anesthesia*: We feel strongly that a general anesthetic increases the hazard, and that all procedures should be done under local anesthesia. That this survey has produced no statistical evidence to support this position does not contravene the difficulty of detecting incipient reactions in the anesthetized patient, or the potential hazard of summation of the effect of the contrast agent on the respiratory center and the respiratory depressant effect of the anesthetic.

7. *Catheter Positioning*: It is desirable always to use an opaque catheter or to make it opaque with a small volume of the contrast agent. Its position must be carefully checked just prior to injection, and there must be absolute certainty that it is not in the innominate or carotid artery. Similarly, care must be exerted when the tip is in the ascending aorta that the injection not be made directly into a coronary artery.

8. *The Patient's State of Hydration*: That portion of the contrast medium which travels down the abdominal aorta and reaches the renal artery will be excreted by the kidneys in high concentration. Only a small fraction is filtered through the glomeruli, the bulk of the medium being excreted by the tubular cells. If the patient is dehydrated, the contrast agent will pass through the kidney in even higher concentration, and with the small volume of urine being produced, the danger of a nephrotoxic effect may be augmented. It is thus important that all patients be adequately hydrated prior to aortography.

9. *Continuous Electrocardiography*: In spite of the fact that many observers consider electrocardiography superfluous, it seems wise when dealing with a complicated diagnostic procedure to utilize every

possible sign of reaction. The presence of marked T-wave changes during an initial unsatisfactory injection might thus preclude a second injection at the time of the procedure. If a severe arrhythmia develops, it is useful to have precise information as to its character prior to instituting therapy.

10. *Arterial Repair*: It is essential that continuity be reestablished whenever possible in arteries which have been cannulated for aortography. This can usually be done in all but the smallest infants. In some instances, we have been forced to sacrifice the brachial artery, but the collateral circulation is apparently sufficiently elastic in infants so that we have observed no subsequent impairment of circulation in the forearm or hand. In adults, however, this occurred in a few instances. In order to decrease the possibility of thrombosis, a continuous infusion of normal saline into the artery should be maintained immediately before and after injection of the opaque medium.

11. *Sensitivity Tests*: We routinely inject 0.5 c.c. of the contrast agent prior to the procedure and observe the patient's reactions, as well as the electrocardiographic strip, before proceeding. In a few instances this has caused us to change the medium, but there seems to be very little correlation between sensitivity testing and major reactions. Medicolegal factors dictate the routine employment of sensitivity testing.

12. *Contraindications*: Severe acute or chronic renal disease with azotemia and severe diffuse cerebral disease should probably preclude the use of thoracic aortography. A known history of allergy warrants careful consideration of the desirability of undertaking the procedure.

Finally, a word must be said about the team aspects of this technic. Thoracic aortography should not be considered a simple radiologic study, to be performed casually without prior preparation. The pediatrician, cardiologist, internist, surgeon, anesthesiologist, and radiologist may all be intimately concerned with the procedure, and hence aortography must be a

collaborative effort. Final responsibility should rest with the radiologist, however, and it is for him to judge whether the indications are sound and the information to be obtained sufficiently important to justify the risk. As proficiency with the technic increases, the appreciation and use of adequate safeguards will reach a point where technical errors contributing to the risk are minimized. This implies that the procedure has its greatest usefulness in institutions where a large volume of operable cardiovascular disease is handled. Reasonable familiarity with the potential risk is mandatory if thoracic aortography is to continue to serve a useful function.

SUMMARY AND CONCLUSIONS

1. Twenty-nine deaths were recorded in a series of 1,706 thoracic aortographic examinations.

2. When a 70 per cent concentration of the medium was employed, the mortality rate was eight times higher than with concentrations of 30-35 per cent.

3. Retrograde carotid injection was attended by a higher mortality than brachial or catheter injection.

4. No deaths followed the use of retrograde brachial aortography with 30-35 per cent media.

5. Most of the deaths and severe reactions appeared to be associated with cerebral damage. Severe renal reactions were also noted, as were cardiac and respiratory disturbances.

6. A number of recommendations are made, designed to forestall severe reactions.

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SUMMARIO IN INTERLINGUA

Le Hasardos de Aortographia Thoracic Retrograde: Un Revista

Un revista del hasardos de aortographia thoracic retrograde esseva facite super le base del responsas a un questionario inviate a 170 institutiones de Nord- e Sud-America e de Europa. Esseva trovate que 45 institutiones non utiliza iste manovra. Inter le 59 institutiones que reportava lor uso de illo, 41 suppleva informationes appropriate pro le analyse.

Vinti-nove mortes e 26 sever complicationes non-mortal esseva reportate in un total de 1.706 aortogrammas thoracic. Le mortalitate amontava a 1,7 pro cento.

Le concentration del substantia de contrasto esseva un factor importante in le causation de complicationes. Le mortalitate esseva circa octo vices plus alte con concentrationes de 70 pro cento que con concentrationes de 30 a 35 pro cento. Nulle assertion conclusive pote esser facite in re le effecto de varie dosages, sed il es

notate que 11 del 29 mortes sequeva le uso de 2 o plus injectiones, e le dosages in multes del casos mortal esseva alte.

Injectiones directe a in le arteria carotic esseva etiam recognoscite como un factor que augmenta le procentage del complicationes in comparison con le procentage associate con injectiones in le arteria brachial o con le uso de un technica a catheter. Nulle mortes occurreva post aortographia brachial retrograde con substantias de contrasto de un concentration de 30 a 35 pro cento.

Le majoritate del mortes e del reactiones sever esseva apparentemente associate con lesiones cerebral. Esseva etiam reportate plure reactiones renal e de mesmo disturbance cardiac e respiratori.

Es facite un numero de recommendationes con le objectivo de evitar serie reactiones.

A Survey of Complications of Abdominal Aortography¹

JOHN G. McAFEE, M.D.²

REVIEWS OF THE literature in 1953 (10) and 1954 (21) revealed that many complications had been associated with abdominal aortography. Since then, numerous other reports of complications have been published. The frequency of these unfortunate occurrences, however, is not known. In order to obtain data on this aspect, a questionnaire was sent to 450 hospital radiologists and urologists in the United States in April 1956. A reply was received from 301 (66 per cent of the total); complete information was obtained from 194 and incomplete information from 12. Ninety-five of the institutions replied that no abdominal aortograms had been performed.

A total of 13,207 abdominal aortograms were collected from the replies to the questionnaires: of these, 12,832 were obtained by the translumbar needle technic; in only 375 was a retrograde femoral catheter used. Insertion of the catheter was performed by a cut-down in 141 cases, and percutaneously in 234 cases. The catheter method, it appears, is being used very little in the United States.

Wide differences in the use of abdominal aortography were noted in institutions of approximately equal size. In many large hospitals no more than one or two dozen procedures have been performed. The greatest use of the method appeared to be in the diagnosis and localization of intrinsic diseases of the aorta and its branches. In most centers, its use in renal lesions has become rather limited, especially in the differentiation between renal cysts and neoplasms, because some diagnostic failures have occurred (7). In a few institutions, however, renal arteriography is still being used extensively. At one center, the procedure has been abandoned in the pre-

TABLE I: SURVEY OF 13,207 ABDOMINAL AORTOGRAMS

Complications	Fatal	Serious Non-Fatal
Renal	12	27
Neurological	5	24
Hemorrhage	5	8
Cardiovascular	5	8
Gastrointestinal	5	5
General anesthetic	3	7
Retroperitoneal sepsis	1	2
Dissecting aneurysm	1	0
Respiratory	0	11
Catheter insertion	0	5
Gangrene of skin	0	1
TOTAL	37 (.28%)	98 (.74%)
	135 (1.02%)	

operative evaluation of aortic aneurysms.

In the collected series of 13,207 abdominal aortograms, there were 37 fatalities attributable to the procedure, a mortality rate of 0.28 per cent. In addition, 98 serious non-fatal complications occurred (0.74 per cent). The overall incidence of serious fatal and non-fatal complications in this study was thus 1.02 per cent. These were all clinically significant and do not include asymptomatic hematomas, asymptomatic renal damage, transient skin or mild systemic reactions, extravasation of the injected contrast medium, or post-aortogram chills or fever. The types of complications are listed in Table I in their probable order of importance, and will be discussed individually. In general, they appeared to be well distributed in both large and small institutions. Of 16 centers at which more than 200 procedures have been performed, only 4 had not encountered one or more major complications.

RENAL DAMAGE

Clinical Manifestations: Following the injection of the aorta or renal artery, there may be immediate pain and tenderness in the flank, costovertebral angle, entire

¹ From The Johns Hopkins Hospital, Baltimore, Md. Presented at the Forty-second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2-7, 1956.

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abdomen, or back. Sometimes there are an abnormal rise in the blood pressure and a slowing of the pulse rate. Prostration or shock, nausea, vomiting, headache, and fever have often occurred. Rhinorrhea, hoarseness, hiccups, and swelling of the salivary glands have occasionally been observed. Infrequently, convulsions have developed. A single case of immediate gross hematuria was recorded in the survey, and only a few instances have been previously described (11, 16). Paralytic ileus (16) and generalized joint pain and swelling (3) have been seen in the early stages. In only a few cases of renal damage have urticaria or other allergic skin manifestations appeared.

Evidences of renal insufficiency usually do not appear for a few days. In some cases, there has been no clinical evidence whatsoever of serious complication for three or four days. Oliguria or anuria occurs commonly in cases of bilateral renal injury, lasting from a few days to several weeks. The usual findings are albuminuria, cylindruria, white blood cells and red blood cells in the urine, and elevation of the non-protein nitrogen of the blood. Associated with the decreased renal output, there are often a gain in weight, puffiness of the eyelids or face, or more generalized edema. Uremic pericarditis has been seen in a few cases. In a few instances where complete anuria has persisted for weeks, the patients have recovered through the use of an artificial kidney. Renal function studies have sometimes revealed a return to normal as early as ten days, but functional impairment may continue as long as six to eight months following the procedure. In a few cases, serious retroperitoneal hemorrhage or neurological damage has been associated with renal damage. The 12 renal fatalities in this survey, occurred from twelve hours to thirteen days following aortography, from uremia.

If renal damage is suspected clinically, it is important that any renal surgery be delayed for several weeks. In one reported case a left nephrectomy was performed a few days following a direct right renal

TABLE II: INCIDENCE OF RENAL COMPLICATIONS

	No. of Procedures	Renal Complications
Total survey	13,207	39 (0.3%)
Over 40 c.c. per injection	1,732	17 (1.0%)
Renal artery injection	104	13 (12.5%)
Aortic block	—	10
No explanation	—	7
Insufficient data	—	2

artery injection and the patient died of renal failure in six weeks (15).

X-ray films of renal damage induced by aortography have almost always shown a disproportionate amount of contrast medium entering the renal arteries, producing an abnormally dense and persistent nephrogram (Fig. 1). Delayed films may show biliary excretion of the medium.

Although several institutions reported instances of abnormal renal function following aortography in the absence of clinical symptoms, these were not considered to be complications in the survey. In a series of 200 femoral catheter aortograms reported by Idbohrn (14), there were only 2 examples of clinically significant renal damage, yet routine renal studies before and after the examination showed slight elevation of the non-protein nitrogen in 5 per cent, albuminuria in 8 per cent, and minimal cylindruria in 10 per cent.

Etiology: The risk of injury to the kidneys depends on the quantity of contrast medium reaching them. In centers where over 40 c.c. of contrast medium were used for each injection, the incidence of complications was tripled (Table II). In one-third of the 39 serious injuries, the injection was made either directly into a renal artery or into the aorta at the origin of a renal artery; the right renal artery was involved in 11 of the 13 cases. In 1 instance, direct injection into an aberrant right renal artery caused temporary damage confined to the lower pole of the kidney. In 10 cases, the damage occurred in patients with thrombotic aortic obstruction, which caused a disproportionate amount of contrast medium to flow through the renal vessels. In 7 cases, injury occurred in the absence of aortic obstruction or

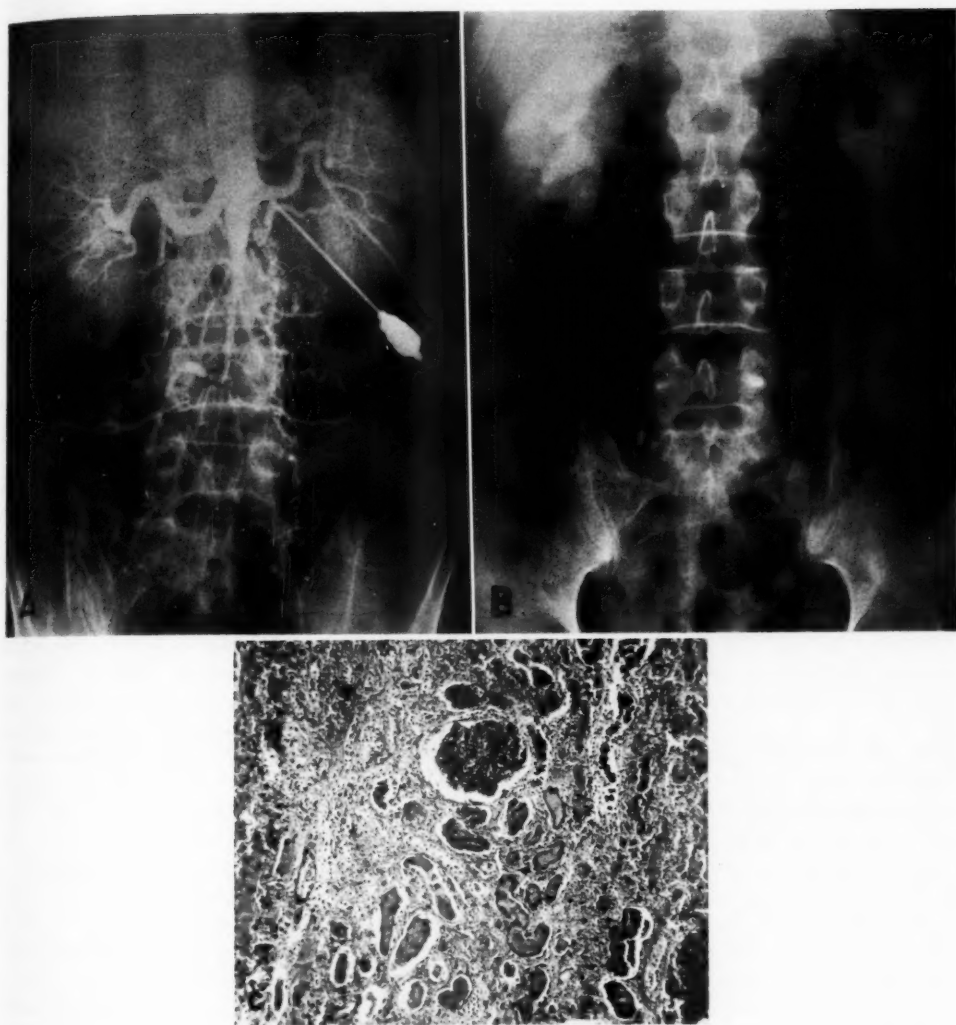


Fig. 1. Renal damage from abdominal aortography.

A. After injections of 10 and 25 c.c. of 70 per cent Urokon, there is excessive filling of the renal arteries due to the high aortic obstruction.

B. The twenty-minute film shows abnormally prolonged and dense opacification of the renal parenchyma. Signs of uremia appeared a few days later. Death occurred on the sixth day during attempted resection of the aorta.

C. Photomicrograph of right kidney ($\times 100$) reveals diffuse acute hemorrhagic necrosis with glomerular and interstitial hemorrhage. The necrotic tubules are filled with debris.

renal artery injection, and without an excessive dose of contrast medium. At a few centers where two aortic needles were used simultaneously or a mechanical injector was employed, the incidence of renal complications appeared to be unduly high. In one series of 16 femoral catheter aortograms performed with aortic compression

(5), impairment of renal function developed in 5 cases, as evidenced by albuminuria or elevation of the non-protein nitrogen of the blood.

The influence of previously disturbed renal function on the incidence of renal damage could not be evaluated in this survey. However, in 19 cases of injury

TABLE III: CONTRAST MEDIA IN ABDOMINAL AORTOGRAPHY

	Urokon 70%	Neo-Iopax 75%	Diodrast 70%	Others	Total
No. of procedures	6,445	2,854	1,965	486	11,750
No. of complications	44	4	30	1	79
Rate	0.68%	0.14%	1.53%	0.21%	0.67%
Renal complications	19	3	15	0	37
Rate	0.29%	0.11%	0.76%	0	0.31%

appearing in the European literature, including 4 fatalities, Idbohrn (14) found evidence of pre-existing renal disease in almost every instance; in several of this group, the femoral catheter technic was employed. The use of contrast media for intravenous urograms immediately prior to aortography has a questionable influence on the incidence of renal damage (14). Hypotension, resulting in slowing of the renal circulation, has been incriminated as a factor (4).

In 2 cases in the survey, injections of as little as 10 c.c. and 15 c.c. of 70 per cent Urokon directly into a right renal artery caused temporary impairment in renal function. In another case with aortic obstruction, 15 c.c. of 70 per cent Urokon plus two test injections of 8 c.c. produced transient uremia. Temporary damage has been reported after the injection of 12 c.c. of 75 per cent Neo-Iopax directly into a renal artery (11). One fatality has resulted from the direct injection of only 15 c.c. of 75 per cent Neo-Iopax into a renal artery (16), in the presence of pre-existing renal disease.

The incidence of all complications, including renal lesions, was lower with 75 per cent Neo-Iopax than with other contrast media (Table III); however, almost all studies with Neo-Iopax were done at one center reporting a large series, so that this difference is not statistically significant. The incidence of all complications (including renal injuries) was more than twice as great with 70 per cent Diodrast than with 70 per cent Urokon. Since these complications were well distributed among many institutions, this difference is probably statistically significant. It must be pointed out, however, that this finding may be due in part to more experi-

ence and skill in the examinations with Urokon than in the studies done with the older medium, Diodrast. Experience with other media (chiefly 50 per cent Hypaque and 50 per cent Miokon) is rather limited, but the complication rate thus far is only about one-seventh of that for 70 per cent Diodrast. These newer media have a lower concentration of iodine than the older media, so that an exact comparison is not possible.

Renal damage has been produced experimentally in rabbits by Idbohrn and Berg (15), by injection of either the left renal artery or the abdominal aorta obstructed below the renal arteries. These authors considered the damage to be due to a direct toxic effect of the contrast medium on the renal parenchyma. Marked individual variation in the tolerance of the kidneys to the contrast medium was found. The relatively low concentration of 17.5 per cent Umbradil (Diodrast) produced renal damage; the situation, however, was not comparable to clinical aortography, because the renal circulation was temporarily shut off during the injection.

Pathological Changes: The renal damage due to aortography has often been called "lower nephron nephrosis" (4) on clinical grounds, but the cases which have been studied pathologically have shown marked changes in the glomeruli in addition to the tubular effects. With severe injury, acute diffuse hemorrhagic necrosis has sometimes involved the entire kidney (Fig. 1). In less severe damage, the areas of degeneration and necrosis may be more focal. A few peripheral renal infarcts have occurred. In patients with pre-existing hypertension, it has sometimes been difficult to separate the pathological changes of that condition from those of

the renal damage. The end stage of the injury may be diffuse renal atrophy with poor function or none at all.

In one reported case with autopsy (16), the toxic renal reaction was similar in appearance to that in heavy metal poisoning. The kidneys were swollen, with fine cortical hemorrhages. Necrosis and subcapsular hemorrhage were seen in the glomeruli, and extensive tubular destruction, desquamation, and regeneration occurred chiefly in the proximal convoluted tubules.

In the experiments of Idbohn and Berg on rabbits (15), immediate pallor of the kidney was observed, followed by hyperemia and swelling. Microscopically, the earliest change was hyperemia of the glomeruli followed by an albuminous exudate in Bowman's capsule. Eosinophilic-staining tubular exudate appeared within minutes, followed by exudation, necrosis, and pyknosis of the tubular epithelial cells, especially in the distal convoluted tubules. Often the kidneys returned to a normal appearance within three days. The extent of damage varied from minute focal areas to complete involvement of an entire kidney.

NEUROLOGICAL COMPLICATIONS

Clinical Manifestations: The commonest manifestation of neurological damage is transverse myelitis or paraplegia. The flaccid paralysis of the lower extremities with complete anesthesia from the level of T-8 or T-9 downward is usually noted as the patient recovers from the general anesthesia. The full extent of the neurological damage, however, may not be apparent for twenty-four hours. Often, there are urinary retention, urinary incontinence, and rectal incontinence. The initial flaccid paralysis may later become spastic. Pain or numbness of the lower extremities may be an early complaint. In one reported case, immediate generalized convulsions occurred during the injection and lasted about ten seconds (1). In some cases of paraplegia, anesthesia is incomplete or absent. Vibration and position sense may be preserved (1).

In some instances, the neurological damage has been transient, in others permanent. Sometimes recovery has taken place slowly over many months. The 5 neurological fatalities included in the survey occurred from two days to one month following the procedure, usually from pneumonia or pulmonary edema. Intercostal paralysis may play an important role in the development of pulmonary complications (22). In patients who have been bedridden for prolonged periods, marked weight loss and decubitus ulcers have developed (1).

In several cases encountered in this survey, the neurological damage has not been serious. The paralysis has involved only one lower extremity or has been confined to muscles supplied by the sciatic or obturator nerves. In a few patients a transient or permanent foot drop has been the only neurological manifestation. Occasionally causalgia of the lower extremities persisting for several months after aortography has been the only manifestation.

Etiology: Although the spine has been inadvertently punctured on a few occasions during aortography, most cases of neurological damage are not due to direct injection into the spinal canal. The films of most cases have shown the needle to be well placed in the upper abdominal aorta. Furthermore, in one fatal case of paraplegia (22), the needle was inserted into the aorta under direct vision during abdominal surgery. Spinal punctures performed following these complications have revealed normal fluid and normal pressures (1, 6, 22). The damage has usually been attributed to a direct toxic action of the contrast medium on the spinal cord (1, 22). Transient spasm of the spinal arteries following injection has been suggested as a cause of the spinal cord ischemia (1). Extensive extravasation of the medium has also been incriminated (7).

The risk of neurological complications probably increases as larger amounts of contrast medium enter the radicular arteries. In this survey, the incidence of neurological complications at institutions using injections of over 40 c.c. was two and one-



Fig. 2. Neurological damage following translumbar aortography in a nine-year-old child, with Vinethene and ether anesthesia. The marked lumbar scoliosis rendered the needle insertion difficult. Two test injections and two final injections of 15 c.c. of 70 per cent Urokon were given. On recovery from the effects of the anesthetic, transient paralysis and anesthesia of both legs occurred. Note the position of the needle tip at L-2, the renal anomalies, and the extravasation of the medium extending into the thoracic duct.

half times that for the entire series (Table IV). However, as little as 10 c.c. of 70 per cent Urokon has resulted in neurological damage (6, 28). Several cases in the literature have occurred in the presence of aortic obstruction (1, 22, 28), but only 2 definite instances were found in this survey. Dilated lumbar arteries secondary to obstruction (22) and marked opacification of lower intercostal arteries (28) have been described.

The "major anterior radicular artery," the principal vessel supplying the spinal cord, usually arises singly from a left lumbar artery, often at the level of L-2 but occasionally as high as T-8 or as low as L-4 (27). There are usually no radicular

TABLE IV: INCIDENCE OF NEUROLOGICAL COMPLICATIONS

Total Procedures	No. of Procedures 13,207	Complications 29 (0.22%)
Urokon	6,445	11 (0.17%)
Diodrast	1,965	7 (0.36%)
Neo-Iopax	2,854	0
Other media	486	1 (0.20%)
Over 40 c.c. per injection	1,732	10 (0.58%)
Aortic block	—	2

arteries in the mid-thoracic region, and only one in the lower thoracic area. In several reported cases, the tip of the aortogram needle has been at the level of L-2 or L-3 (1, 6, 22), the usual site of origin of the major radicular branch (Fig. 2). The rather wide distribution of this artery in the spinal cord may explain why the usual upper level of the neurological damage at T-8 or T-9 is considerably higher than the site of injection into the aorta at L-2.

In the original case of neurological damage from aortography in the literature (2), the authors claimed that aortic compression from a pillow under the abdomen was an important factor. Abdominal compression alone has been known to cause paraplegia in man (2) and in animals (12).

In this survey, the incidence of complications following spinal anesthesia was significantly higher than that following either general or local anesthesia (Table V). Also the neurological complication rate appeared to be definitely lower with local anesthesia than with general or spinal anesthesia. Furthermore, 2 of the 3 cases of damage under local anesthesia were merely transient episodes of foot drop. In all of the cases with neurological complications found in the literature, general anesthesia was used (1, 2, 6, 22). This higher incidence of complications with general or spinal anesthesia may be due to greater muscular relaxation in the prone position, allowing some degree of aortic compression, poorer filling of the anterior visceral vessels, and greater filling of the dorsal vessels.

Tarazi, Margolis, and Grimson (28) produced spinal damage in dogs with bar-

TABLE V: ANESTHESIA IN ABDOMINAL AORTOGRAPHY

	Local	General	Spinal	Total
No. of procedures	3,408	8,228	677	12,313
No. of complications	22	61	14	97
Complication rate	0.65%	0.75%	2.06%	0.79%
Neurological complications	3	18	2	23
Rate	.09%	0.22%	0.29%	0.19%

biturate anesthesia and large amounts of contrast medium injected into the thoracic or the abdominal aorta. Marked individual variation in the susceptibility of the animals to injury was noted. The incidence of paraplegia following injection of Urokon was somewhat higher than with Diodrast. The findings were similar to those of Whiteleather (31), who produced cerebral damage by the injection of contrast media into the carotid artery of dogs; Urokon was found to be somewhat more toxic and Hypaque somewhat less toxic than Diodrast. In this survey, some differences in the neurological complication rates with 70 per cent Urokon, 70 per cent Diodrast, and 75 per cent Neo-Iopax were found, but these were not of statistical significance.

Working with rabbits, Hol and Skjerven (12) concluded that the incidence of experimentally induced spinal cord damage was increased by repeated injections at short intervals, pre-existing disease of the spinal cord, prolonged exposure to the medium, aortic obstruction or compression, or hypotension. The incidence of damage was much higher with the animals in the supine position.

Pathological Findings: Although the neurological injury may simulate thrombosis of the anterior spinal artery, this has not been present in the few cases in man studied pathologically (1, 22, 28). In the affected areas of the cord, necrosis and demyelination of the gray matter have been found (1, 2), especially in the ventral and lateral columns (1). There may be massive necrosis, liquefaction, and cavity formation in certain regions (1). In later stages, areas of gliosis may be seen (1). In their experimental studies on rabbits, Hol and Skjerven observed changes chiefly in the gray matter, the

white matter being involved only in severe damage. In the first forty-eight hours, edema, hydropic degeneration, chromatolysis of neurones, and hemorrhage were observed. From four to thirty-four days following injection, areas of necrosis were seen, varying from minute scattered foci to massive 10 cm. lesions. Foamy macrophages developing from microglia were sometimes seen.

HEMORRHAGE FROM THE AORTIC PUNCTURE SITE

Although many hematomas were reported in the survey, in only 13 instances were these accompanied by shock and therefore considered to be serious complications; 5 of these were fatal. The hematomas were usually retroperitoneal, but sometimes were perirenal, peritoneal, or superficial. In 1 case, in which the needle punctured the aorta at a rather high level, a large left hemothorax occurred, with surgical shock (Fig. 3). In most instances, the bleeding and shock were observed within one or two hours, but in 1 patient the hemorrhage developed slowly over a two-day period. The hematoma may often be demonstrated on a twenty-minute pyelogram following the aortogram, with obliteration of the left psoas line and lateral displacement of the left kidney.

Of the 13 patients with serious bleeding, 7 had hypertension, usually of the malignant type. In 3 instances, the bleeding followed the direct puncture of an aortic aneurysm. In 2 patients, neither hypertension nor aneurysm was present, and in the 1 remaining case, the information supplied was incomplete. At least 25 instances were recorded in the replies to the questionnaires in which abdominal aortic aneurysms were punctured without serious hemorrhage.

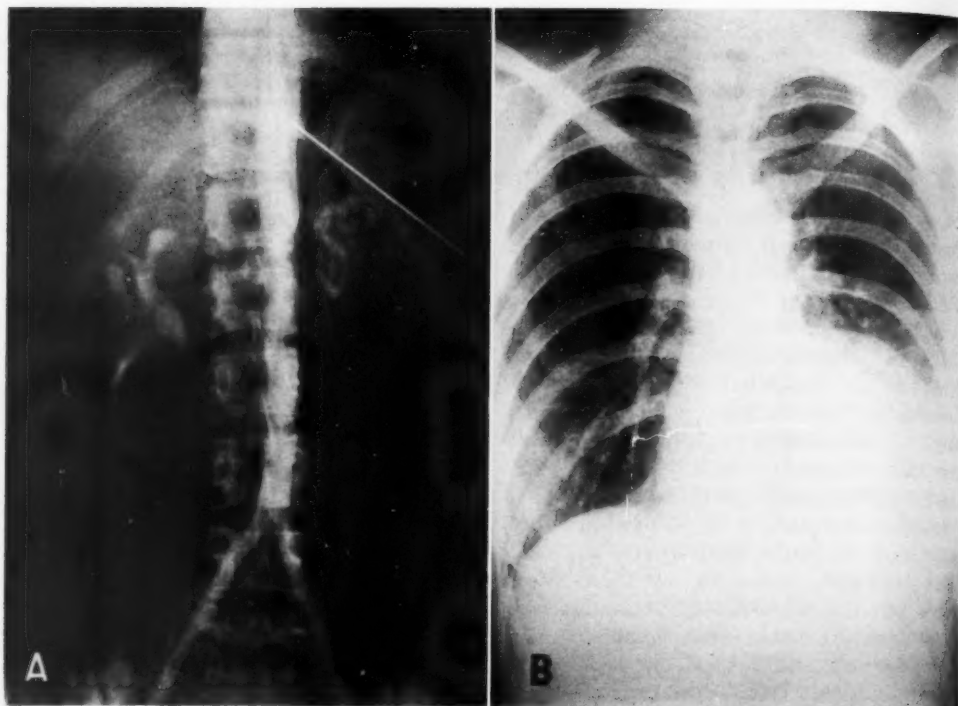


Fig. 3. Hemothorax and shock immediately following aortography in an eighteen-year-old hypertensive female.
 A. Aortogram needle inserted at an abnormally high level under local anesthesia. Atrophic pyelonephritis of the left kidney was poorly demonstrated.
 B. Chest film a few minutes following needle withdrawal showing large left hemothorax. Patient recovered from shock in half an hour. Two weeks later 900 c.c. of old blood were aspirated from the left chest.

In 1 case, the needle punctured an aneurysm at the origin of the left renal artery; a hematoma developed which obstructed the left ureter, causing a temporary left hydronephrosis. In a fatal case previously reported from the Johns Hopkins Hospital (21), a hypertensive patient, tilted on the x-ray table with the needle in place, experienced a serious retroperitoneal hemorrhage.

For the vast majority of the translumbar aortograms in this survey, the needle sizes were Nos. 16, 17, and 18. No definite differences in the incidence of hematomas were noted when the larger bore needles were employed.

The frequency of insignificant hematomas during aortography could not be accurately determined from this survey. Some replies reported that small ecchymoses could be found at the puncture site

in almost all cases at surgery following aortography. At various institutions, the estimated percentage of insignificant hematomas ranged from 1 per cent to 20 per cent. Occasionally, these minor hematomas were accompanied by back pain and tenderness. In the Johns Hopkins Hospital series of 300 abdominal aortograms, hematomas of over 500 c.c. were found in 8 cases, or 2.5 per cent, but only 3 of these were clinically significant.

CARDIOVASCULAR COMPLICATIONS

Thirteen serious cardiovascular reactions were encountered, with 5 fatalities. Several occurred in elderly, poor-risk patients. In 7 out of 10 instances, intravenous Pentothal was used for anesthesia. In 5 patients surgical shock developed within several minutes of the aortic injection; all recovered. In 3 patients cardiac arrest

for a few minutes to one hour followed injection, and 1 of this number recovered. Acute left heart failure following injection under general anesthesia proved fatal in 1 instance. In another patient with mitral rheumatic heart disease, marked hypertension developed, persisting for about six hours; death occurred, from a cerebral embolus, eight hours following aortography. This fatality was not considered to be directly attributable to aortography.

In 3 instances, an acute coronary occlusion developed within two hours following recovery from Pentothal anesthesia, with a fatal outcome in 2. A few coronary occlusions were seen one or two days after aortography, but these were arbitrarily omitted from the list of complications. Williams, Fullenlove, and Bryan (32) reported a case of cardiac infarction following aortography under general anesthesia; severe hypotension had been noted at the time of the procedure. Blood pressure changes during aortography tend to be more marked under general than under local anesthesia (20); an immediate hypotension has been noted, followed by hypertension lasting for several minutes. An abrupt elevation of the blood pressure with a slowing of the heart rate may be indicative of an impending complication (28).

Two fatalities have been reported (17, 25) in patients with adrenal pheochromocytoma: retroperitoneal hemorrhage and intractable shock developed in one and six hours, respectively, and death occurred in twenty-four and thirty-six hours.

GASTROINTESTINAL COMPLICATIONS

Ten gastrointestinal complications of various types were reported, 5 of which were fatal, following injection of either 70 per cent Diodrast or 70 per cent Urokon. Three injections were made directly into the superior mesenteric artery, with 2 fatalities from gangrene of the bowel; in 1 of these, thrombosis of the superior mesenteric artery was found postmortem. In the non-fatal case, severe abdominal pain and paralytic ileus persisted for a few days. The bowel was perforated in 2

cases. In 1 of these, with perforation of the small bowel and free peritoneal air, recovery ensued. The other patient experienced immediate severe pain and died of peritonitis after several days. Two direct injections of the inferior mesenteric artery with gangrene of the left colon occurred, 1 of which was fatal. In the other, thrombosis of the artery was found at operation, and the gangrenous bowel from the mid-transverse colon to the anus was resected successfully. One case of necrosis of the rectum and 1 of hemorrhagic proctitis without necrosis were described.

In the older literature on aortography at least 2 fatalities (29, 30) were recorded from gangrene of the bowel following injection of 80 per cent sodium iodide into the superior mesenteric artery. Subsequently, experimental injection of the superior mesenteric artery of dogs by Melick, Byrne, and Boler (23) clearly demonstrated that 80 per cent sodium iodide was dangerous, and that organic iodine-containing media were considerably safer; Urokon was considered to be somewhat less harmful than either Diodrast or Neo-Iopax. More recently it has become apparent that the use of organic media has reduced, although not entirely eliminated, bowel complications of aortography.

Paralytic ileus has sometimes been associated with a renal complication (9) or a neurological complication (22).

One unusual complication was reported in the survey. A constriction of the abdominal aorta caused unusual filling of the celiac axis, with immediate right upper quadrant pain, mass, and fever, and death in one month. Postmortem, necrotizing arteritis and hemorrhagic inflammation of the pancreas, adrenals, and gallbladder, attributable to the Diodrast injection, were found. In addition, there was a massive retroperitoneal and subphrenic hematoma. In another fatal case of acute pancreatic necrosis, reported (24) in the literature, dense filling of the celiac axis with 70 per cent Urokon resulted from high aortic obstruction.



Fig. 4. Perforation of iliac artery by retrograde catheter without serious clinical symptoms. Note the extravasated medium.

COMPLICATIONS OF GENERAL ANESTHESIA

In 10 cases in the survey, certain complications were considered to be attributable to general anesthesia with intravenous Pentothal rather than to the contrast medium injection; 3 of these were fatal. Six instances of laryngospasm with marked cyanosis were encountered, with 1 fatality. Similar examples have appeared in the literature (20). One case of cardiac arrest was attributed to the Pentothal, but a single injection of 70 per cent Urokon was given. One patient showed marked hypotension on recovering from the anesthesia, and this was managed successfully with intravenous cortisone; in another case left cerebral and subarachnoid hemorrhage occurred, with recovery in four weeks.

RETROPERITONEAL SEPSIS

In 3 instances in this survey, infection was apparently introduced by the needle puncture, with 1 fatality. In another

patient, a perinephric abscess with pleural extension required surgical drainage.

DISSECTING ANEURYSM

In 1 patient with aortic obstruction, death occurred three days following aortography, and a dissecting aneurysm of the aorta and renal arteries was found, which apparently had developed following the procedure. In another case, with massive retroperitoneal hemorrhage, dissection along a renal artery was found postmortem, two months later.

RESPIRATORY COMPLICATIONS

Eleven complications involving the respiratory system were encountered, none of which was fatal. Four patients had symptomatic pneumothorax, and 3 hemopneumothorax. Two instances of chylothorax resulted from trauma to the thoracic duct. Complete severance of the duct, necessitating surgical ligation, has been described (20). In 1 patient acute respiratory failure occurred immediately following injection and another experienced an acute asthmatic attack.

Small asymptomatic pleural effusions have been reported (13, 19, 20), as a result of puncture of the pleura.

COMPLICATIONS OF CATHETER INSERTION

In 5 of the 375 cases in which aortography was done by the retrograde femoral catheter technic, local complications occurred at the site of insertion. These included localized sloughing at the puncture site, a traumatic femoral arteriovenous fistula necessitating surgical repair, and large subcutaneous hematomas. In one series of 42 percutaneous femoral aortograms, localized hematomas of some extent developed in 4 (10 per cent). Intramural injection of the contrast medium at the tip of the catheter with the production of intense transient pain was described. In 1 instance, a catheter tip broke off during insertion, becoming an embolus, requiring amputation of the leg. Perforation of arterial walls by the catheter has occurred, without significant complications (Fig. 4).

GANGRENE OF THE SKIN

An unusual patchy gangrene of the skin of the abdomen, back, scrotum, and thighs developed in a diabetic on the day following aortography with 70 per cent Urokon under general anesthesia.

EXTENSION OF ARTERIAL THROMBI

The possibility of arterial thrombi becoming more extensive as a result of aortography has been mentioned as a danger by Leriche and Morel (18), especially in patients with impending gangrene. Both in the literature and in this survey, however, there is surprisingly little evidence that this has occurred. In 1 patient in the survey, intermittent claudication became definitely worse following the procedure. Another patient with a high aortic thrombosis died incidentally one week following aortography, an extension into the renal artery having developed in the interim. In 2 cases of renal damage, extension of an aortic thrombus into a renal artery was found.

MINOR COMPLICATIONS OF AORTOGRAPHY

Structures other than the abdominal aorta were inadvertently punctured without serious complication in 3 per cent of the studies in this survey, as listed in Table VI. Many instances of direct injection into the celiac axis or superior mesenteric artery were recorded which produced either no symptoms or merely transient abdominal pain or discomfort; occasionally minor degrees of instability of the



Fig. 5. Filling of right internal spermatic artery, producing transient intense testicular pain. Most of the aortic injection was intramural.

blood pressure and diarrhea were also noted. There were also many inconsequential direct injections into the renal arteries, either producing no symptoms or manifested only by transient flank pain, or the appearance of white blood cells, red blood cells, and casts in the urine for a few days. In two instances, injection into the internal spermatic artery caused transient, intense testicular pain (Fig. 5).

TABLE VI: MISPLACEMENT OF NEEDLE TIP WITHOUT COMPLICATIONS
11,116 Aortograms; 324 Incidents (3 per cent)

Arterial	No. of Cases	Non-Arterial	No. of Cases
Celiac	98	Inferior vena cava	7
Superior mesenteric	94	Spinal canal	2
Right renal	80	Pleura	2
Left renal	11	Bowel	2
Splenic	7	Heart	1
Lumbar	4	Hemiazygos veins	1
Internal spermatic	4	Thoracic duct	1
Inferior mesenteric	3	Vertebral body	1
Intercostal	2	Renal cyst	1
Hepatic	1	Renal tumor	1
		Pancreas	1
TOTAL	304	TOTAL	20

The non-arterial structure most commonly punctured was the inferior vena cava. No significant symptoms from this cause were found in the survey. In a case from the literature (26), a direct injection into the inferior vena cava caused temporary respiratory arrest, which responded to resuscitation. In another reported case, accidental puncture of the kidney produced a small renal hematoma (20). The azygos vein has apparently been entered without complication (29); included in the survey was 1 case of direct injection into the hemiazygos system, with pericardial pain and transient electrocardiographic changes. In another case the heart was punctured and angiocardigraphy was inadvertently performed. In an accidental puncture of the pancreas, 10 c.c. of 70 per cent Urokon were injected and the serum amylase was elevated on the day following the procedure.

The literature records 1 case in which paresthesia and weakness in one lower limb persisted for several weeks following the use of tourniquets around the thighs during aortic injection (20).

The incidence of urticaria in four fairly large series in the survey was from 2 to 6 per cent. The incidence of nausea and vomiting in four institutions varied from 4 to 8 per cent.

Intramural injection or extravasation of the contrast medium has usually caused immediate back pain or epigastric pain, usually disappearing promptly. In a small percentage of cases the pain may persist for two or three days, occasionally accompanied by slight fever, leukocytosis, and epigastric discomfort. The incidence of this minor complication in 96 institutions ranged from 1 to 20 per cent, but in over half of the institutions the incidence was between 5 and 10 per cent.

SUGGESTIONS FOR PREVENTION OF COMPLICATIONS

Although complications associated with the performance of aortography can never be entirely eliminated, certain measures, in the light of this survey, will probably

reduce their frequency considerably. Because some of the incidents, even in retrospect were unavoidable, the examination should never be performed without clear indication.

1. A test film after injection of 5 c.c. of the medium with the aortic needle in place should be performed routinely (30) to guard against direct injection into the renal arteries or other aortic branches. In this survey, only about half of all institutions performed preliminary intra-aortic injections.

2. The aortic needle should be inserted at a high level, well above L-2. If examination of the kidneys or upper aorta is not required, insertion should be well below the level of the renal arteries. This also enables better visualization of the femoral and other peripheral arteries.

3. Local anesthesia is indicated in most patients to minimize the danger of neurological damage. In apprehensive, uncooperative subjects, intravenous Pentothal must be used; the period of anesthesia should then be as short as possible.

4. Abdominal compression or the two-needle aortogram technic should be avoided.

5. Excessive amounts of contrast medium (over 30 c.c.) should not be used and as few injections should be made as possible, particularly when the kidneys are exposed to the medium. Rapid serial films enable complete renal studies with a single injection. If the femoral arteries cannot be well visualized without use of excessive amounts of the medium, direct percutaneous femoral arteriography is indicated.

6. The scant available evidence thus far indicates that the newer contrast media may be safer than either Urokon or Diodrast. Except in heavy individuals, satisfactory studies can usually be obtained with a 50 per cent concentration.

7. In patients with high aortic obstruction, satisfactory studies may be obtained with no more than 12 to 15 c.c. of medium, and usually a single injection suffices.

8. Direct puncture of an aortic aneurysm must be guarded against, because of the danger of hemorrhage.

9. A routine twenty-minute pyelogram

film should be obtained to detect the presence of retroperitoneal bleeding; hypertensive patients should be closely observed for this complication.

10. The effectiveness of preliminary injections of antihistamines or cortisone in preventing serious systemic reactions to contrast media has not yet been established. Severe reactions, however, have responded dramatically to intravenous preparations of cortisone. At least one fatal systemic reaction in this survey was not prevented by preliminary antihistamine injection.

SUMMARY

1. A survey of 13,207 abdominal aortograms reported in reply to questionnaires sent to hospital radiologists and urologists in the United States revealed 37 deaths and 98 serious complications. The overall complication rate was 1.02 per cent and the mortality rate 0.28 per cent.

2. Renal damage from the contrast medium was the most important complication, usually resulting from excessive injections, direct renal artery injections, or injections in patients with high aortic obstruction.

3. Neurological damage appeared to be an important hazard, sometimes resulting in prolonged morbidity. The danger appeared to be increased by the use of spinal or general anesthesia, by excessive injections of medium, and by the proximity of the needle tip to the major anterior radicular artery, usually at the level of L-2.

4. Less frequent complications include hemorrhage from the puncture site and cardiovascular, gastrointestinal, and general anesthetic disturbances.

5. Suggestions for reducing the incidence of these complications are given.

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SUMMARIO IN INTERLINGUA

Le Complicationes de Aortographia Abdominal: Un Revista

Un total de 13.207 aortogrammas esseva reportate in responsa a un questionario inviate a radiologos e urologos hospitalari in le Statos Unite. Le grande majoritate de iste aortogrammas haveve essite obtenite per le technica a agulia translumbar. Le revista del serie total revelava 37 mortes e 98 casos de serie complicationes. Le mortalite esseva 0,28 pro cento. Le incidentia de mortes e serie complicationes insimul esseva 1,02 pro cento.

Insultos renal causate per le substantia de contrasto esseva le plus importante complication. Illos resultava usualmente ab injectiones excessive, ab injectiones reno-arterial directe, o ab injectiones in patien-

tes con alte grados de obstruction aortic.

Insulto neurologic representava apparenemente un risco importante. In certe casos illo resultava in morbiditate prolongate. Il pare que le periculo esseva augmentate per le uso de anesthesia spinal o general, per excessive injectiones del substantia, e per le proximitate del puncta del agulia al major arteria antero-radicular, usualmente al nivello de L-2.

Le minus frequente complicationes include hemorrhagia ab le sito del punction e disturbationes cardiovascual, gastrointestinal, e de anesthesia general.

Es facite proponimentos pro reducer le incidentia de iste complicationes.



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Coproliths¹

R. M. BERG, M.D., and H. M. BERG, M.D.

THE PURPOSE of this paper is again to remind the radiologist to be "coprolith-conscious." Coproliths were not diagnosed in our department before 1949. In the first five years after we had become "coprolith" conscious, however, 42 cases were seen, of which 35 were diagnosed preoperatively and 8 postoperatively because the surgeon requested an x-ray study of the removed appendix. This report will be limited to the cases with a preoperative diagnosis.

The word "coprolith" is derived from the Greek, meaning "dung stone." It is used, according to the suggestion of Thomas (1), to emphasize the radiopacity of the concretion and thus distinguish fecaliths which are visible roentgenographically from others frequently found in the appendix. In his study of a large series of fecaliths, only 25 per cent contained enough calcium to be visualized on an abdominal film.

The first mention of appendiceal stone was made in 1813 by Wegeler (2). The first report of a correct preoperative x-ray diagnosis was that of Weisflog (3) in 1906. Seelig (4) in 1908 introduced the term "coprolith" and was the first to describe this condition in the American literature. Since that time, there has been a multitude of reports. An extensive review of the literature is unnecessary in view of the excellent analyses of Felson and Bernhard (5) and Laforet *et al.* (6), in 1947 and 1951, respectively.

The mechanism of coprolith development proposed by Kelly and Hurdon (7) in 1905 is the most widely accepted. They propose that impairment of the normal peristaltic return of fecal content from the appendix results in inspissation. Subsequent irritation and accompanying bacterial activity due to the fecal mass cause

a low-grade inflammation with mucus secretion. The inorganic salts, mainly calcium phosphate, contained in the mucus are precipitated on the surface of the fecal nucleus, producing an increase in size.

Wangensteen and Bowers (8) suggest that the appendix frequently behaves as a closed loop in relation to the intestinal canal, permitting entry but preventing free extrusion of the fecal stream; the coprolith is then formed in the lumen by stasis upon the fecal nucleus. These authors stress the closed loop phenomenon as the initiating factor in appendicitis and regard inflammation and suppuration as consequences of the obstruction. This explains why a patient may have a coprolith for some time before the development of acute appendicitis. Maver and Wells (9) studied the chemical composition of a number of coproliths and found the content to be as follows: material soluble in fat solvents (mainly soaps with considerable coprosterol), 50 per cent; inorganic material (mainly calcium phosphate), 25 per cent; organic residue (mainly vegetable fibers), 20 per cent.

Approximately 130 cases of coproliths have been reported to date. The frequency of their occurrence as given in the literature varies considerably according to the material from which the cases are selected. Bunch and Adcock (10) reported only 1 case in 2,000 appendectomies, whereas others have recorded an incidence as high as 10 per cent in acute appendicitis. A compilation of all the figures found in the literature gives an average incidence of about 5 per cent. We cannot draw any conclusions as to the incidence from our series, since only an occasional patient with appendicitis had an x-ray examination.

The age distribution in the present series differs somewhat from that in the ear-

¹ From the Department of Radiology, Quain and Ramstad Clinic, Bismarck, N. D. Accepted for publication in December 1956.

lier reports, the majority of our patients being under twenty-one years of age. Apparently, the youngest patient in which a preoperative diagnosis was previously reported was five and a half years of age (11). Eleven of our patients were below this age (Table I). The sex distribution

TABLE I: AGE DISTRIBUTION OF 35 CASES OF COPROLITHS DIAGNOSED PREOPERATIVELY

0 to 5 years.....	11
5 to 10 years.....	5
10 to 15 years.....	6
15 to 20 years.....	2
20 to 30 years.....	6
30 to 40 years.....	2
40 to 50 years.....	2
50 to 60 years.....	1

of previous cases gives the males a marked preponderance, in agreement with the general incidence of appendicitis, but 55 per cent of our series were females.

A calcified shadow or shadows in the right lower quadrant should immediately suggest the possibility of the presence of a coprolith. The shape is usually oval, but round, cylindrical, triangular, and irregular shadows can occur. Most coproliths are from 5 to 20 mm. in diameter, but they range from just barely visible to 30 to 40 mm. in diameter. Most coproliths are laminated in appearance, but solid and mottled varieties are seen. The number present varies from 1 or 2 to as many as 23, as in a case reported by Shahan (12). They are usually found in the right lower quadrant, but may occur in the right upper quadrant, the left lower quadrant, or the minor pelvis.

A number of conditions can simulate coproliths. *Bone islands* have a similar appearance, but can usually be confirmed by taking films in several projections. Gallstones are uncommon in the first two decades and in most instances can be differentiated by history, location, or cholecystography. *Ureteral and vesical calculi* may be a source of confusion; they can ordinarily be ruled out by pyelography (Case V). *Calcified mesenteric lymph nodes* can be recognized by their more generalized distribution and the spotty appearance of the calcification in

TABLE II: PATHOLOGICAL FINDINGS IN 35 CASES OF VERIFIED COPROLITHS ASSOCIATED WITH ACUTE APPENDICITIS

Acute catarrhal appendicitis.....	5
Acute suppurative appendicitis.....	11
Gangrenous appendix.....	6
Perforated appendix.....	11
Chronic recurrent appendicitis.....	1
No inflammation present.....	1

the individual nodes. *Phleboliths* and *vascular plaques* are not troublesome when multiple calcifications are present. These are also rare in the younger age group, where coproliths occur most commonly. Most *foreign bodies* are recognizable radiologically.

In several cases, *radiopaque medications* have caused some difficulty in diagnosis. With this in mind, we obtained specimens of each oral medication available on the ward and radiographed them through an abdomen. Over 50 per cent were dense enough to be visible. Enteric-coated tablets, antacids, and diuretics cast the densest shadows. A history of ingestion of such preparations will assist in the differential diagnosis. Serial films demonstrating progression of the drugs are obtained in doubtful cases. Retained radiographic contrast materials are usually recognizable as such by the history and close examination of the film.

Calcified appendices epiploicae are rare. They can usually be shown to move throughout the abdominal cavity by filming in different positions. In the single case seen, 5 were present, confined to the right abdomen. They moved freely from the lateral abdominal wall to the right upper and right lower quadrant. They did not cross the spine, however, in the left lateral decubitus position. *Ovarian and uterine calcification* should cause little difficulty due to the location, diffuse appearance of the calcification, and larger areas of involvement.

An x-ray examination of the abdomen is not obtained in a case of clear-cut appendicitis. This series, therefore, represents cases in which the symptoms or physical findings were not characteristic. Generalized abdominal pain, right flank



Fig. 1. Case I. S. Z., female, age 4. Abdominal film revealing a coprolith below the right iliac crest.



Fig. 2. Case II. G. C., female, age 6. Upright film revealing two coproliths below the right iliac crest. The insert is a film of the operative specimen.

pain, periumbilical pain, right and left upper quadrant pain, and right hip pain are the recorded presenting complaints in the majority of cases. A review of the histories reveals that 50 per cent of the cases would not have had sufficient evidence, without the x-ray findings, for exploration, despite the history, and physical and laboratory examinations. In 4 cases, the physical examination was entirely normal, although acute symptoms were present (Cases IV and V).

The pathological findings (Table II) reveal that most cases represented acute appendicitis. The single case with no inflammation was that of an asymptomatic eleven-year-old girl, who had an interval appendectomy on the basis of multiple previous attacks and the x-ray findings. Chronic recurrent appendicitis was found in a girl of nineteen with abdominal pain of two days duration, mild epigastric and right lower quadrant tenderness, and a white cell count of 7,800. Surgery was

TABLE III: FINAL DIAGNOSIS IN 6 CASES WITH AN ERRONEOUS X-RAY DIAGNOSIS OF COPROLITH

Age	Diagnosis
2 yr.	Bronchopneumonia
2 yr. (no coprolith shadow shadow found on re-examination three days later)	Gastroenteritis
3 yr.	Pyelitis
7 yr.	Right ureteral calculus
59 yr.	Acute cholecystitis
75 yr.	Pancreatitis

performed because of the x-ray findings. In 48 per cent of the series the appendix was gangrenous or perforated. This figure agrees fairly well with the average obtained upon tabulation of the other cases reported in the literature.

During the period from which this series was taken, an erroneous diagnosis of coprolith was made in 6 patients with acute abdominal symptoms. The final diagnoses in these cases are presented in Table III. An additional 13 cases were seen in which a possible coprolith was an incidental finding during other radiological procedures. These patients were in the later decades of



Fig. 3. Case III. S. H., male, age 3. Abdominal film revealing a large coprolith at the right iliac crest.

life and had no acute symptoms (Table IV). To date, none have returned with acute abdominal complaints. Three of the proved cases were originally in this group, but the patients have returned with acute symptoms. The interval was four years in one case and two months in each of the other 2 cases.

A few illustrative cases follow:

CASE I: S. Z., a 4-year-old girl, was seen with generalized pain of twenty-four hours duration. Bilateral rectal tenderness was the only positive physical finding. No abdominal spasm or tenderness was present. The white blood cell count was 22,600, with 91 per cent polymorphonuclears. Urinalysis was normal. A roentgenogram (Fig. 1) revealed a right lower quadrant calcification. At surgery, an acute suppurative appendix with a small periappendiceal abscess and a coprolith was removed. The x-ray finding was the deciding factor for immediate operation.

CASE II: G. C., a 6-year-old girl, had right flank and costovertebral angle tenderness. Her white blood cell count was 18,850. An occasional white cell was present on urinalysis. Otherwise the exam-



Fig. 4. Case IV. B. L., male, age 10. Lower abdominal film revealing a large coprolith over the right ilium.

TABLE IV: AGE DISTRIBUTION OF 13 CASES IN WHICH A POSSIBLE COPROLITH WAS AN INCIDENTAL FINDING, NO ACUTE ABDOMINAL SYMPTOMS

0 to 10 years	0
10 to 20 years	1
20 to 30 years	1
30 to 40 years	1
40 to 50 years	2
50 to 70 years	8

ination was normal. The roentgenogram (Fig. 2) revealed two calcified shadows. At operation on the same day, an acute suppurative appendix was removed, containing two coproliths (Fig. 2, insert).

CASE III: S. H., a 3-year-old boy, was admitted with a one-week history of tonsillitis, fever and anorexia. He had had constipation, abdominal pain, and abdominal rigidity for two days. His temperature was 103°. Examination revealed tonsillitis, moderate abdominal rigidity, and generalized abdominal rebound tenderness. A roentgenogram (Fig. 3) revealed dilated small bowel and right lower quadrant calcification. The patient improved on medical management, and at operation, two weeks later, was found to have a perforated appendix with a coprolith free in the abscess cavity.

CASE IV: B. L., a 10-year-old boy, was first seen at 6 A.M. after vomiting all night. He exhibited slight spasm and right lower quadrant tenderness. The admission examination two hours later revealed no abdominal tenderness or spasm. The temperature was 99°. The white cell count was 19,000. At 2 P.M. this had risen to 21,000 and the temperature to 102°, but the physical examination remained normal. The surgical consultant requested an abdominal film (Fig. 4), which revealed a large coprolith. The pathologic report on the removed appendix was acute suppurative appendicitis with coprolith.

CASE V: L. K., a 12-year-old boy, was admitted with acute vomiting and fever. No pain or tenderness was present. The white cell count was 25,000. Urinalysis was normal. The abdominal film showed a calcific shadow over the lower part of the right sacroiliac joint. An intravenous pyelogram, performed to rule out a ureteral calculus (Fig. 5), showed that the calcification was extra

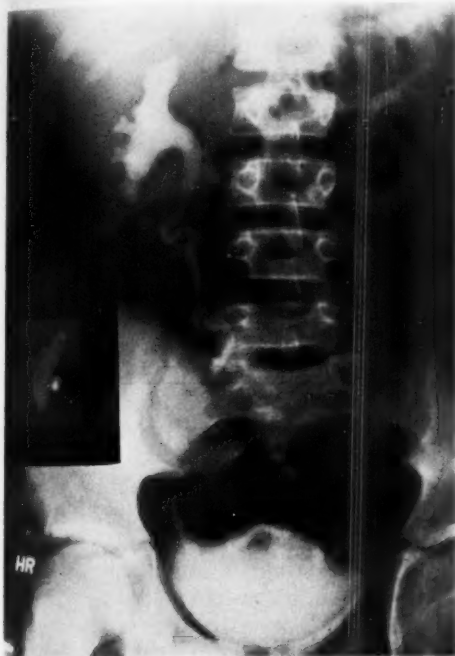


Fig. 5. Case V. L. K., male, age 12. Intravenous pyelogram revealing a coprolith at the lower border of the right sacroiliac joint with partial obstruction of the right ureter.

ureteral, but that a partial obstruction of the ureter was present at the level of the shadow. At operation, a perforated appendix with an abscess around the ureter and a coprolith was found.

CASE VI: R. P., a 7-year-old boy, was initially seen at home because of dehydration and debilitation. The admission film (Fig. 6) revealed three coproliths. Because of the child's poor condition, conservative treatment was necessary for a month before surgery was possible. At operation, an abscess cavity containing the coproliths was found and drained.

CONCLUSIONS

1. Coproliths are not an infrequent finding, 42 cases having been seen in five years.



Fig. 6. Case VI. R. P., male, age 7. Abdominal film revealing three coproliths in the right sacroiliac region.

2. The condition is most frequent in the younger age groups.

3. The correct diagnosis can frequently be achieved only by x-ray examination of the abdomen. Other findings were insufficient to justify a diagnosis of appendicitis in half of the series reported.

4. In the presence of a coprolith in a patient with acute abdominal symptoms, there is at least a 90 per cent chance that the patient has an acute appendicitis, and a 48 per cent chance that the appendix is gangrenous or perforated.

5. A survey of the literature reveals that most authors recommend an immediate appendectomy whenever a coprolith is found. The findings in this series are in agreement so far as the younger patients are concerned. Operation would not appear to be necessary in the symptom-free older patients.

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SUMMARIO IN INTERLINGUA

Coprolithos

Ben que le autores habeva diagnosticate nulle coprolithos ante 1949, a partir de lor haber devenite "coprolitho-conscie" illes faceva iste diagnose in quatro annos in 35 casos con subsequente prova operatori.

In plus que un medietate del casos, le correcte diagnose esseva facite super le base exclusive de observationes a radios X, con le altere constatactiones remanente inconclusive. Un umbra (o umbras) calcificate in le quadrante dextero-inferior debe esser considerate immediatemente como un indication del possibilitate de coprolitho.

Le majoritate del casos es associate con appendicitis acute. Absentia de inflammation esseva constatate al operation in solmente un del casos del autores. Le probabilitate que un patiente con un coprolitho ha appendicitis acute amonta a 90 pro cento, e le probabilitate que le appendice es gangrenose o perforate amonta a 48 pro cento.

Appendicectomy immediate es recommendate in patientes de plus juvene etates. Illo non es considerate como un necessitate in patientes de etates plus avantiate si illes es sin symptomatas.



Hemangioma of the Small Intestine¹

SEYMOUR OCHSNER, M.D., and RAWLEY M. PENICK, Jr., M.D.

HEMANGIOMAS of the small intestine are rare lesions, of particular importance to the radiologist since they severely test his diagnostic capabilities. None of the common fluoroscopic procedures are so time-consuming and so likely to be unrewarding as studies of the small intestine. Discovery of a benign neoplasm is one of the rarer potential rewards of this method of examination (3-5).

A full collective report on gastrointestinal hemangiomas by Kaijser (9) in 1936 introduced the classification that has proved most useful:

1. Multiple phlebectasia
2. Cavernous hemangioma
 - (a) Diffuse infiltrating
 - (b) Circumscribed (often polypoid)
3. Capillary hemangioma
4. Angiomatosis

In a recent comprehensive review of tumors of the small intestine, River *et al.* (14) analyzed the data of 1,399 cases recorded in the literature. They stressed the frequency and importance of complications, especially intussusception, obstruction, and intraluminal bleeding. Of the 1,399 tumors, only 79 had been correctly

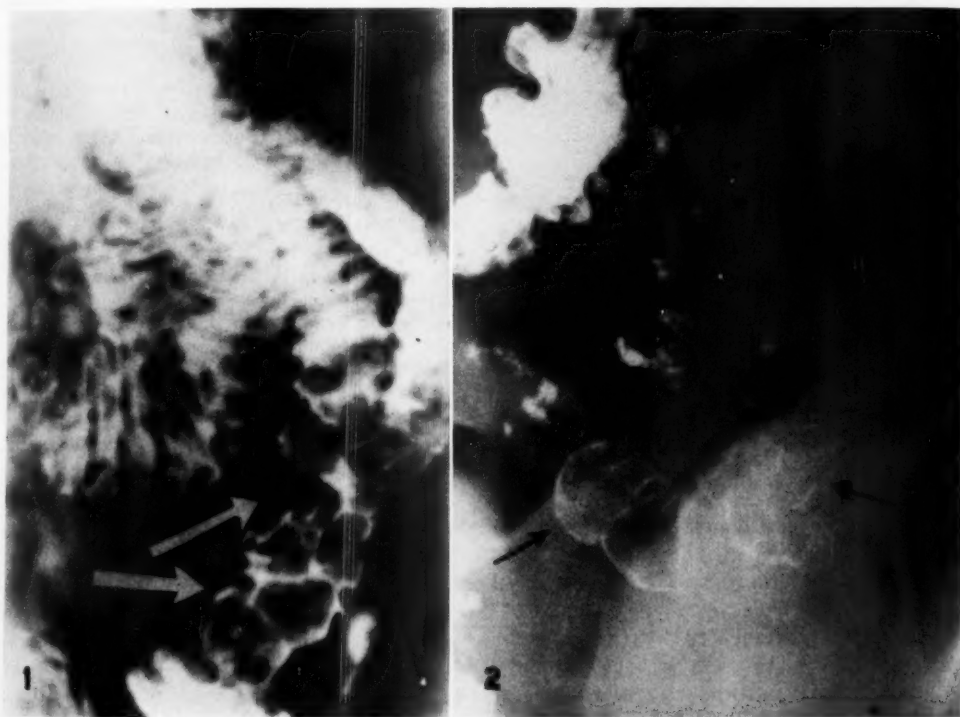


Fig. 1. Spot roentgenogram of a jejunal loop showing multiple filling defects at site of hemangioma.

Fig. 2. Roentgenogram of abdomen, made four hours after ingestion of barium mixture, showing the jejunal hemangioma covered with a thin coating of barium. Most of the barium had passed into the colon.

¹ From the Departments of Radiology (S. O.) and Surgery (R. M. P.), Ochsner Clinic, New Orleans, La. Accepted for publication in December 1956.

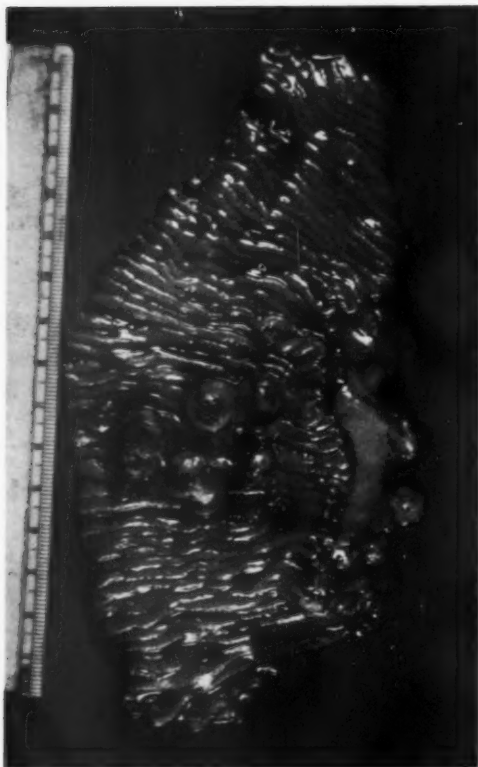


Fig. 3. Photograph of capillary hemangioma of polypoid type in the resected segment of the jejunum.

diagnosed before operation, in each instance on the basis of roentgenologic evidence. In the collected series there were 127 vascular tumors, forming 9 per cent of the entire number. In only 3 of these had a preoperative radiologic diagnosis of benign tumor been made.

Among 20 cases of benign tumors of the small intestine seen at the Ochsner Clinic and Ochsner Foundation Hospital between 1942 and 1955, one was a jejunal hemangioma, which was clearly portrayed roentgenologically. This was of the capillary type, a variety infrequently found in the small intestine (1, 5, 12, 13) and so rarely visualized radiologically that the case is considered worthy of report.

P. A. L., a 16-year-old girl, daughter of a white farmer, came to the Ochsner Clinic on Feb. 9, 1950, complaining of abdominal cramps. She had been

anemic since the age of seven years, when she was thought to have had an attack of acute nephritis. Intermittent episodes of abdominal pain had led to an appendectomy six months before admission.

Physical examination revealed pallor and slight generalized edema. Hematologic studies indicated only severe hypochromic microcytic anemia, apparently resulting from chronic loss of blood. The hematocrit reading was 26 per cent, hemoglobin 5.6 gm. per 100 ml., and red blood cell count 4,100,000 per cu. mm. Mean corpuscular volume was 63 cubic microns and mean corpuscular hemoglobin concentration 21.5 per cent. Fecal examination revealed a trace of occult blood.

Roentgenologic studies of the chest, urinary tract, and colon revealed no disease. The esophagus, stomach, and duodenum appeared normal roentgenologically. Examination of the small intestine, Feb. 13 and Feb. 15, showed several soft polypoid filling defects in a segment of the mid-jejunum (Fig. 1). There was neither narrowing nor deformity of the intestine, and no evidence of obstruction or intussusception. The delayed film showed a cluster of peculiar, rounded, barium-coated lesions in the left side of the abdomen. These suggested some type of benign tumor of the jejunum, possibly a hemangioma or lipoma (Fig. 2).

On Feb. 20, 1950, abdominal exploration revealed a segmental area of redness in the mid-jejunum with enlarged mesenteric vessels and soft intraluminal masses. A segment measuring 17 cm. was resected.

Pathologic examination showed 7 polypoid lesions arising in the mucosal surface, varying from 0.5 to 1.5 cm. in diameter (Fig. 3). These bulged beneath the mucosa, were reddish blue in color, soft, and partially covered by a greenish yellow exudate. Microscopic examination showed them to be vascular tumors, composed of capillaries of varying size. The *histologic diagnosis* was multiple capillary hemangiomas of the jejunum, with superficial ulceration and inflammation.

Recovery was prompt, and at this writing the patient remains well more than six and a half years postoperatively.

DISCUSSION

When there is a real indication for thorough roentgenologic exploration of the small intestine, a conscientious examination should be performed, and results are at times rewarding (2, 7, 16). Persistent chronic or recurrent periumbilical pain, diarrhea in the absence of disease of the colon, and obscure intestinal bleeding are the prime indications for examination. The relatively low incidence of bleeding small intestinal lesions is put in proper

tive by consideration of the report of Smith and coworkers (15), who found that 95 per cent of the cases with melena or hematemesis, of non-colonic origin, would be found in the upper gastrointestinal tract (the duodenum or above).

Individual examiners have their own preferences as to the proper procedures to follow. We agree with Hodges and coworkers (7) that a simple routine type of examination is useful as a screening method for large volumes of work. Basic procedures, however, should never be so standardized that they are not adaptable to the individual case.

Roentgenologic findings in tumors of the small intestine include intraluminal filling defects, disordered motility, stenosis or angular narrowing of the lumen, regional dilatation, and intussusception (2, 5, 6, 8, 10, 14). Phleboliths occur in hemangiomatous tumors, but we found none reported in hemangiomas of the small intestine.

Dedick and Collins (4) found that the two principal causes of failure to detect lesions by small intestinal studies were (a) a disregard for slight alterations in pattern of intestinal loops and (b) uneven and irregular distribution of barium in the lumen as a result of flocculation of the mixture or abnormal motor function of the small intestine.

In the repeated absence of positive roentgenologic findings and in the face of clinical and laboratory evidence of bleeding from the intestinal tract, we believe that surgical exploration deserves strong consideration. Morrison and Donath (11), however, reported a hemangioma discovered by roentgenologic examination after two surgical explorations failed to reveal the cause of intestinal bleeding.

SUMMARY

A case of capillary hemangioma of the small intestine, producing abdominal pain

and chronic severe anemia, has been presented. The tumor was discovered by roentgenologic study and was resected successfully.

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SUMMARIO IN INTERLINGUA
Hemangioma del Intestino Tenue

Es reportate un caso de multiple hemangiomas capillar del jejuno. Le patiente, un puera de dece-sex annos de etate, se plangeva de sever dolores abdominal, e il esseva constatate que illa habeva un alte grado de anemia microcytic hypochromic, apparentemente causate per un perdita chronic de sanguine. Le roentgeno-examine monstrava plure polypoide defectos

de plenamento in le jejuno. Duo dies plus tarde, un roentgenogramma retardate demonstrava un racemo de remarcabile ronde lesiones coperite de barium, Isto suggeriva le presentia de un tumor benigne, possiblementemente lipoma o hemangioma. Le afflicte segmento del intestino esseva resectionate, e le diagnose esseva establite histologicemente.



Radiographic Demonstration of Choledochal Cyst by Oral Cholecystography¹

JOHN E. MOSELEY, M.D.

CHOLEDOCHAL cyst or idiopathic dilatation of the common bile duct is a congenital localized dilatation, the exact etiology of which is at present obscure. While in some cases there may be a stenosis, angulation, or valve-like fold in the lower part of the duct, in others no abnormality can be demonstrated at the outlet. It is considered probable that a congenital weakness of the duct wall results in dilatation when the intraductal pressure is increased as a result of anatomic or functional obstruction at the outlet.

Choledochal cysts have been demonstrated directly by the introduction of contrast substances into the cyst through a needle puncture and indirectly by pressure defects on the duodenum and displacements of the adjacent structures. McLaughlin (1) has reported a case in which the cyst was outlined by gas, apparently from the duodenum. A review of the literature reveals a firm conviction that these cysts cannot be shown by oral cholecystography. In 1935, Wright (2) published a case in which the gallbladder was visualized but not the cyst. In all other cases that we have been able to find in the literature, oral cholecystography, when attempted, has failed to demonstrate the biliary tract. Recently, Wilson (3), in discussing the diagnosis of choledochal cysts in infants and children, states that the gallbladder is not visualized by oral cholecystography. The following case is considered noteworthy, therefore, because both the gallbladder and cystic dilatation of the common duct were demonstrated following the administration of Telepaque.

CASE REPORT

M. T., a 5-year-old white female, was admitted to the hospital May 25, 1955, because of epigastric pain

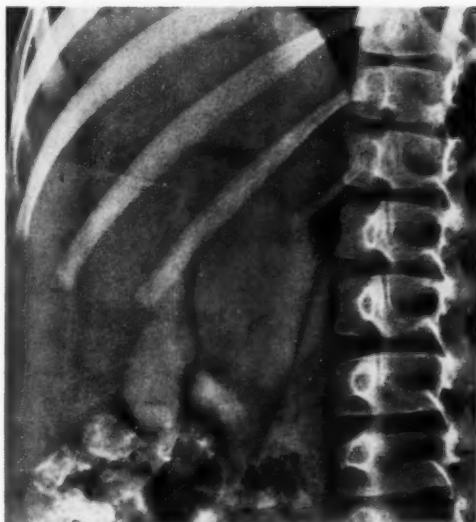


Fig. 1. Cholecystogram made with 0.30 gm. of Telepaque, showing good visualization of gallbladder, cystic duct, and large, smoothly rounded localized dilatation of the common duct.

and vomiting. She had a history of recurrent right upper quadrant pain, nausea, and vomiting from the age of nine months. The attacks of pain occurred at intervals of one or two months and lasted for periods varying from hours to days. At the age of two and a half years, an exploratory laparotomy was performed at another hospital. At that time, nothing of significance was found and a normal appendix was removed. The attacks, however, became more severe and more frequent and the child was admitted to the Mount Sinai Hospital for study during one of these episodes.

In addition to the upper abdominal pain and vomiting, the patient was found to be jaundiced and to have a questionable mass in the right upper quadrant. Fluids were given intravenously for two days, during which time the symptoms diminished and the jaundice cleared. Oral cholecystography was then undertaken, with a dose of 0.15 gm. of Telepaque given in three tables. Faint visualization of the gallbladder was obtained. Because of this success and because the child had shown no reaction to the Telepaque, the examination was repeated with a dose of six tables (0.30 gm.). As a result, the gallbladder and common duct cyst were well demon-

¹ From the Department of Radiology, The Mount Sinai Hospital, New York, N. Y. Accepted for publication in November 1956.



Fig. 2. Barium meal study showing anterior displacement of second portion of duodenum by large opacified choledochal cyst (arrows).

strated (Fig. 1). A gastrointestinal series made the same day showed the duodenum to be displaced anteriorly and downward by the opacified cyst (Figs. 2 and 3). A diagnosis of choledochal cyst was made. This was confirmed on surgical exploration, and a cystoduodenostomy performed.

DISCUSSION

The majority of cases of congenital cystic dilatation of the common duct occur in children and young adults, but the condition has been reported in older persons as well. Its incidence is four times as great in females as in males. The diagnosis may be strongly suggested by the clinical triad of abdominal pain, tumor, and jaundice; the clinical course is characterized by intermittency of the symptoms. The typical triad may be absent, however, in which event the diagnosis may be difficult to establish. Hertzler and Maguire (4), among others, have stressed the importance of preoperative diagnosis, reporting a fatality rate of 62 per cent for patients without a preoperative diagnosis as opposed to 36 per cent for those in whom the diagnosis was entertained before surgery. Gross (5) has also made a strong plea in this respect, warning that the surgeon must be familiar with the pathology of the condition and be prepared to institute proper corrective measures at the operating

table. Any procedure, therefore, which offers the possibility of demonstrating the lesion preoperatively would appear mandatory.

It seems strange that in nearly 200 cases of choledochal cyst that have been reported, we have been able to find only one in which the gallbladder was visual-



Fig. 3. Displacement of second portion of the duodenum anteriorly and downward by the large opacified cyst (arrows).

ized by oral cholecystography and none in which the cyst was opacified. Under these circumstances it is natural that a conviction regarding non-visualization in these cases should take root. While the vast majority of reports appeared before 1950, the few published since that time have also indicated the failure of oral cholecystography to demonstrate either the gallbladder or the cyst. In the case reported here Telepaque was used as the contrast medium. The superior density of this preparation is now well established, and it seems likely that this may have been a contributing factor in the successful visualization. In addition, the patient was not jaundiced at the time of the examination. Although this point is not clear in all reports, in many cases it is apparent that the examination was made while the patient was icteric. Since the jaundice, as

well as other manifestations of the condition, tends to be intermittent, it would seem advisable to await its clearing before attempting oral cholecystography. Cholangitis and biliary cirrhosis are common complications of choledochal cyst and, where these have progressed, it may be impossible to secure visualization by this means. Nevertheless, the demonstration that the gallbladder and cystic dilatation of the common duct can be shown with Telepaque, especially in the non-jaundiced patient, should stimulate renewed interest in and further trial of this simple diagnostic procedure, particularly since the importance of preoperative diagnosis is so clearly recognized.

SUMMARY

A case of choledochal cyst in a five-year-old girl is presented in which both the gallbladder and the cystic dilatation of the common bile duct were demonstrated by oral cholecystography with Telepaque. No previous reports of visualization of a

choledochal cyst by oral cholecystography could be found in the literature.

Successful demonstration of the cyst and gallbladder in this case may be related to the use of Telepaque and the fact that the patient was examined after her jaundice had cleared.

The importance of preoperative diagnosis in reducing mortality from surgery in this condition is emphasized.

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SUMMARIO IN INTERLINGUA

Demonstration Radiographic de Cyste Choledochal per Cholecystographia Oral

Es reportate un caso de cyste choledochal, o de dilatation idiopathic del ducto biliari commun, occurrente in un pueria de cinque annos de etate. Tanto le cyste como etiam le vesica biliari esseva demonstrate per cholecystographia oral per medio de Telepaque, in despecto del facto que on ha generalmente opinare que iste cystes non es visualisabile per tal medios e que nulle reporto de un tal visualisation poteva esser trovate in le litteratura. Il es probabile que le successo del methodo in le

presente caso es connectite con le facto que Telepaque esseva usate, le qual es cognoscite per su densitate superior, e con le factor que le patiente esseva libere de jallnessa al tempore del examine.

Le facto que diagnoses pre-operatori resulta in un grande reduction del mortalitate chirurgic in casos de cyste choledochal servi a sublinear le importantia de tentar cholecystographia oral in patientes de iste genere, preferibilemente durante un periodo quando illes es libere de jallnessa.

Irradiation of Advanced Cancer of the Head and Neck through a Grid

Part I. Study of Absorbed Dose by Observation of Skin and Mucosal Reactions¹

MILTON FRIEDMAN, M.D., and ALEXANDER W. PEARLMAN, M.D.

THE UNCERTAINTY of the biologic effectiveness of the absorbed dose of 250-kv radiation through a *grid* prompted this study of skin and mucosal reactions in 37 of a series of 48 patients with head and neck cancer treated with the grid technic. The reactions were compared with a standard set of epithelitis curves produced in a previous group of patients irradiated through a single *open portal*.

Previous studies of epithelitis and epidermitis curves (1-3) have demonstrated that, despite a wide range of individual variation, these reactions are the only feasible indices in man for quantitative comparison of the absorbed dose with the measured dose. Although epidermitis reaction curves, in the form of skin erythema tests, have been extensively studied as indicators of surface dose absorption, epithelitis curves, a useful indicator of the biologic effect of absorbed radiation in the depth, have been inadequately investigated.

With the epithelitis and epidermitis reaction curves produced by irradiation through a single open portal (1) as a base line, it is possible to seek grid dosages which will produce equivalent reactions.

The open-portal reaction curves were achieved with portals measuring 8×10 or 10×10 cm. The grid had perforations of 1 sq. cm., with 45 per cent of the area open. Most of the thirty-seven grid portals measured 8×10 cm., but 5 measured 10×15 cm. The overall treatment time for both technics was usually five to seven weeks. All doses delivered through a grid are expressed as roentgens "in air," because ionization measurements (5-8) do not satisfactorily

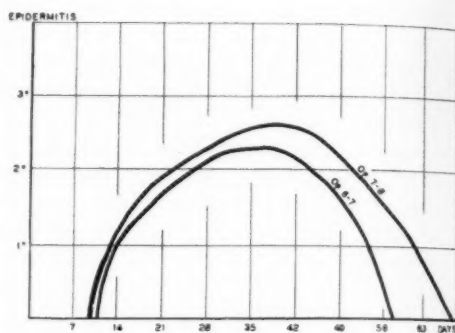


Fig. 1. Average epidermitis curves for the open-portal technic. Curve Op 7-8 is for the dose range of 7,100 to 8,000 r, measured with back-scatter, delivered in four to six weeks, and Op 6-7 for the dose range of 6,100 to 7,000 r.

explain the absorption of grid irradiation in tissue. The quality of radiation was h.v.l. 1.0 to 1.5 mm. Cu.

REACTION CURVES PRODUCED BY THE SINGLE OPEN-PORTAL TECHNIC

Skin Reactions: The criteria for drawing skin reaction curves are those which Coutard described over twenty-five years ago. First-degree erythema is redness of the skin; its day of onset is often indefinite. Second-degree erythema is denudation of the epidermis, with healing from multiple islands of epidermis throughout the irradiated area; its day of onset is a reliable point on the reaction curve. A third-degree erythema is denudation healing from the margins. It is usually necessary to wait until the reaction begins to heal before the curve, representing the magnitude of the reaction, can be drawn. The day of healing is a reliable point on the curve.

The reactions of skin aggressively irradi-

¹ From the Department of Radiology, New York University College of Medicine and the Lila Motley Radiation Therapy Department, Hospital for Joint Diseases. Accepted for publication in December 1956.

ated through a single open portal were illustrated in an earlier paper (1). The average epidermitis curves are reproduced in Figure 1. The lower curve, labeled Op 6-7, is representative of irradiation through an open portal, 6,100 to 7,000 r measured with back-scatter in four to six weeks; Curve Op 7-8 was produced with doses of 7,100 to 8,000 r in five to seven weeks. As expected, the larger dose produced a more severe second-degree epidermitis, of longer duration than the

theritic membrane is a reliable point on the curve.

The original paper on single-portal-massive-dose technic (1) did not include a description of epithelitis curves. These are now presented in order to compare them with epithelitis curves produced by the grid technic. Figure 2 depicts the mucosal reactions produced by the single *open-portal* technic, with skin doses ranging from 6,100 to 7,000 r in four to six weeks. The average epithelitis curve, indicated by

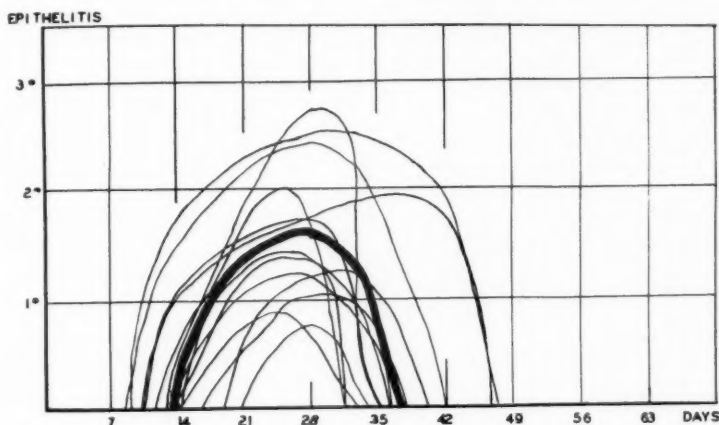


Fig. 2. A nest of curves depicting the individual epithelitis reaction observed in 13 patients treated through a single open portal with a skin dose ranging from 6,100 to 7,000 r (measured with back-scatter), delivered in four to six weeks. The heavy line represents the average curve. In only 3 of 13 patients did the reaction on the mucosal surface exceed a second-degree intensity.

smaller one. These reaction curves will be compared with grid reaction curves.

Mucosal Reactions: The criteria for mucosal reactions are the same as for skin reactions, with few modifications. It is almost impossible to see a first-degree epithelitis. One must rely on subjective symptoms for a mild first-degree reaction, or marked injection and edema of the mucosa. A second-degree epithelitis is indicated by a pseudo-diphtheritic membrane, and its day of onset is a reliable point on the curve. It is difficult to define a third-degree epithelitis, but if a pseudo-diphtheritic membrane has not started to heal within three or four weeks after its onset, it is designated as third-degree. The day of healing of the pseudo-diph-

theritic membrane is a reliable point on the curve. Figure 3 illustrates curves produced by the group of larger skin doses, ranging from 7,100 to 8,000 r. The average curve reached a second-degree intensity. *In all cases the epithelitis was unilateral.* These average curves will be later compared with grid curves.

The stated dose is the skin dose and not the dose in that part of the mucosa which first exhibited a pseudo-diphtheritic membrane. It would have been preferable to specify the tissue dose in the mucosal site where the reaction first occurred, but this was impossible because, in an individual patient, the mucous membrane lay from 2 to 4 cm. below the skin, and each site consequently had a different

dose. Also, the epithelitis was not constant in its location in different patients. Since the skin portal included the lower jaw and upper two-thirds of the neck in almost

standards for comparison with the grid reactions, may be stated as follows: The maximum tolerated skin dose is 7,100 to 8,000 r in five to seven weeks. The average

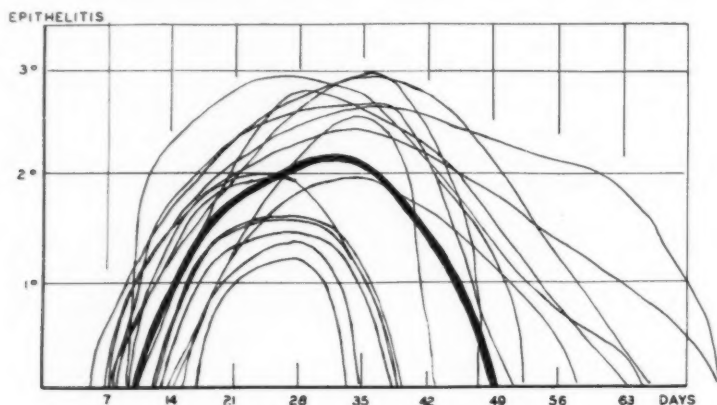


Fig. 3. A nest of curves depicting the individual epithelitis reaction observed in 16 patients treated through an open portal with a skin dose of from 7,100 to 8,000 r (measured with back-scatter), delivered in five to seven weeks. The heavy line represents the average curve. In only 8 of the 16 patients did the mucosal reaction exceed a second-degree intensity.

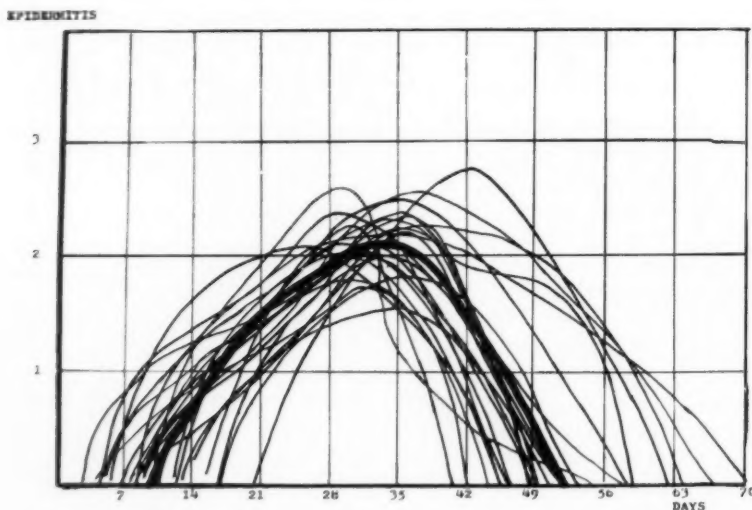


Fig. 4. A nest of curves depicting the individual epidermitis reaction in 23 patients treated through a grid. The dose, measured in air, ranged from 10,000 to 15,000 r in four to six weeks. The heavy line represents the average curve.

every case, it was assumed for the purposes of this experiment that the relative depth doses were similar for each patient.

In summary, the single *open portal* technic reactions, which are to be the

epidermitis from this dose approaches a third-degree skin reaction and heals on the seventieth day. With the lower range of 6,100 to 7,000 r, there is a slight reduction in intensity of the epidermitis (Fig. 1).

The *epithelitis* curves in the two dose ranges have a somewhat different relationship. The average epithelitis curve of the higher skin-dose range (7,100 to 8,000 r)

the multiple pencil-beams of grid therapy. Both dose ranges are clinically similar, however, in that they produce maximum skin reactions short of necrosis.

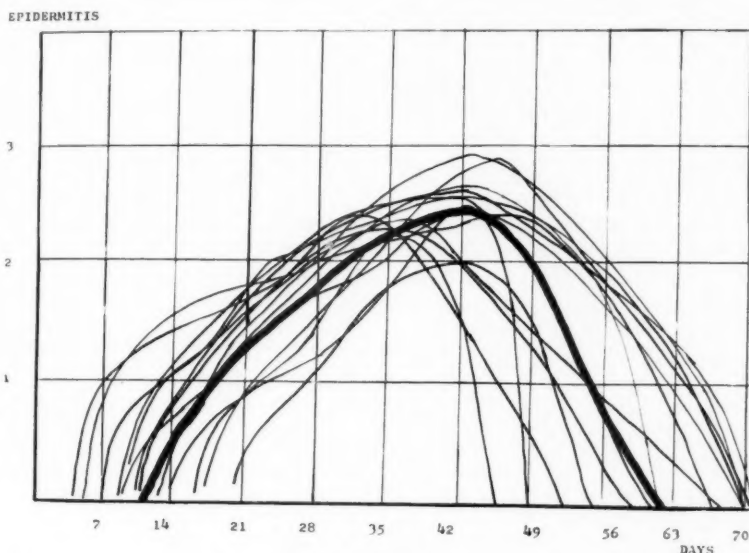


Fig. 5. A nest of curves depicting the individual epidermitis reaction in 14 patients treated through a grid. The dose, measured in air, ranged from 15,100 to 20,000 r in five to seven weeks. The heavy line represents the average curve.

reached a mild second-degree intensity and healed on the forty-ninth day (Fig. 3). With the lower dose range of 6,100 to 7,000 r, the average epithelitis reaction curve was considerably reduced in height and duration (Fig. 2).

REACTION CURVES PRODUCED BY THE GRID TECHNIC

Skin Reactions: The grid patients were divided into two groups, those whose skin reactions were somewhat similar to the *open-portal* reactions produced by doses in the 6,100 to 7,000 r range, measured with back-scatter, and those with reactions comparable to those produced by 7,100 to 8,000 r. The comparable dose ranges with the grid were 10,000 to 15,000 r (air) in four to six weeks, and 15,100 to 20,000 r (air) in five to seven weeks.

Only a crude comparison can be made between the skin reactions following open-portal therapy and the reactions following

Figure 4 depicts twenty-three skin reaction curves produced by doses ranging from 10,000 to 15,000 r (air) through a grid. This lower range of grid dosage produces an average epidermitis curve of second-degree intensity (comparable with Fig. 1, Op 6-7). Figure 5 depicts fourteen skin reaction curves produced by doses from 15,100 to 20,000 r (air) through a grid. This is the higher range of grid dosage and it produces an average epidermitis curve of second-degree intensity comparable with the average epidermitis curve produced with an open portal (see Fig. 1, Op 7-8).

In summary, these skin reactions produced by the maximum tolerated doses are approximately equivalent. The variable to be studied in this experiment is the analogous epithelitis reactions.

Epithelitis Reactions: Figure 6 depicts the twenty epithelitis curves of the lower range of dosage through a grid, 10,000 to

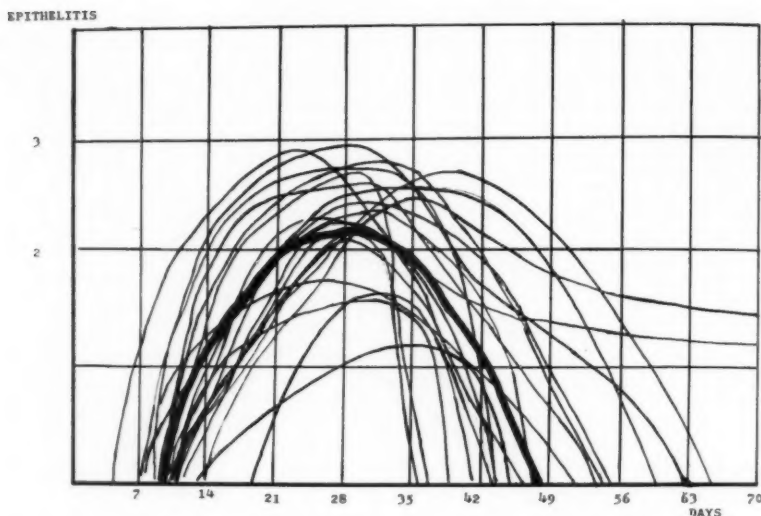


Fig. 6. A nest of curves depicting the individual epithelitis reaction in 20 patients treated through a grid, to a dose, measured in air, ranging from 10,000 to 15,000 r, in four to six weeks. The heavy line represents the average curve. In 16 of the 20 patients the reaction exceeded a second-degree intensity.

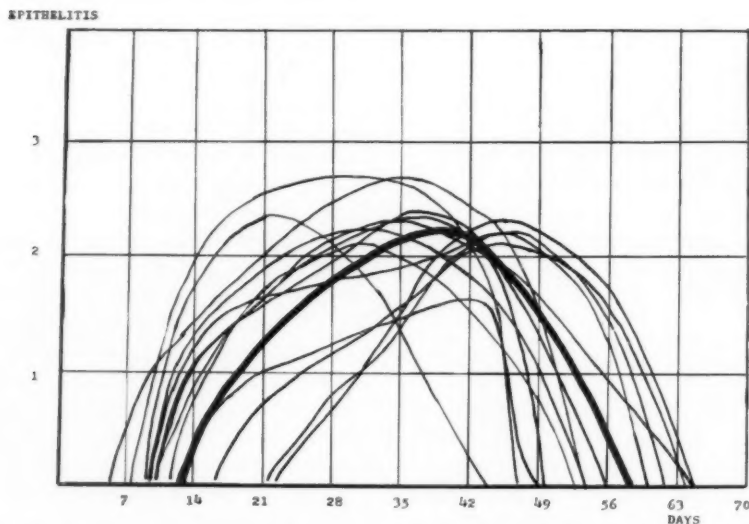


Fig. 7. A nest of curves depicting the individual epithelitis reaction in 13 patients treated through a grid to a dose, measured in air, ranging from 15,000 to 20,000 r, in four to six weeks. The heavy line represents the average curve. In 12 of the 13 cases the reaction exceeded a second degree intensity.

15,000 r (air), while Figure 7 shows the corresponding thirteen epithelitis curves from the high-dosage range, 15,100 to 20,000 r (air). The two average curves differ slightly in that the low-dose reaction

heals on the forty-ninth day and the high-dose reaction lasts until the sixtieth day.

ANALYSIS OF OBSERVATIONS

Since this is a retrospective analysis of a

TABLE I: STUDY OF BIOLOGIC EFFECT (EPITHELITIS AND EPIDERMITIS) IN RELATION TO DOSE*

Administered Doses		Biologic Effect
Open Portal Dose Range (r with back scatter)	Grid Dose Range (r in air)	
7,100 to 8,000	15,100 to 20,000	Maximum tolerated skin dose just short of necrosis
6,100 to 7,000	10,100† to 15,000	Moderately severe second-degree skin reaction
7,100 to 8,000	—	Second-degree epithelitis (7 of 16 cases)
—	15,100 to 20,000	Second-degree epithelitis (12 of 13 cases)
6,100 to 7,000	—	Second-degree epithelitis (3 of 13 cases)
—	10,000 to 15,000	Second-degree epithelitis (16 of 20 cases)

* Usual overall time five to seven weeks.

† The smallest doses in this group were 13,000 r in fifteen days and 12,000 r in twenty days.

series of cancer patients irradiated according to clinical requirements rather than a planned experiment, deductions must be qualified.

A study of skin reactions produced by 200- to 250-kv x-rays shows the maximum tolerated skin dose to be produced by a dose range of 7,100 to 8,000 r (measured with back-scatter) delivered in five to seven weeks through an open portal (Fig. 1), or by a dose range of 15,100 to 20,000 r (air) delivered through a grid (Fig. 5). The average epidermitis curves of the two technics are of second-degree intensity, heal in seven weeks to nine weeks, and are approximately equivalent.

For a lower grade of skin reaction, the dose ranges were 6,100 to 7,000 r (measured with back-scatter) in four to six weeks, through an open portal and 10,000 to 15,000 r (air) through a grid (see Table I).

Let us compare the mucosal reactions (epithelitis) from grid (Fig. 7) with those from open-portal irradiation (Fig. 3), using the higher dose ranges of each. While the respective skin reactions are similar clinically, the average epithelitis with the grid is slightly higher and of longer duration (sixty days) than with the open portal (forty-nine days). With the grid, twelve of thirteen epithelitis curves reached a

second-degree intensity as compared with only seven of the sixteen open-portal curves. When the skin reactions are comparable, the grid produces a more intense and more prolonged epithelitis than the open portal. This is indicative of a larger absorbed dose in the depth.

A similar comparison of epithelitis curves is made in the lower dose range. Both skin reactions are milder but are not exactly similar, in that the grid skin reaction (Fig. 4) is less intense than the open-portal skin reaction (Fig. 1). Nevertheless, the average epithelitis curve with the grid (Fig. 6) is higher than a second-degree intensity. Furthermore, with the grid technic, sixteen of twenty epithelitis reactions are higher than second-degree, whereas with the open portal, only three of thirteen reactions exceed second-degree intensity. Once again it is seen that, for comparable skin reactions, the grid technic results in a larger absorbed dose in the depth.

A striking difference between grid and open-portal technics, when only one treatment portal is employed, is noted by comparing unilateral (ipsilateral) with bilateral epithelitis. The open-portal technic never produced bilateral second-degree epithelitis, whereas the grid technic produced bilateral second-degree epithelitis in one-third of the cases (Table II).

TABLE II: OBSERVATIONS ON MUCOSAL REACTIONS WITH GRID TECHNIC

(33 patients)			
Air Dose	Number of Cases	Unilateral second-degree Epithelitis	Bilateral second-degree Epithelitis
10,100 to 15,000 r	20	13	7
15,100 to 20,000 r	13	9	4
TOTAL	33	22	11

ILLUSTRATION OF A HYPOTHETICAL CASE

A cross-section of the oropharynx at the level of the tonsil is shown diagrammatically in Figure 8. In an average patient, the cervical lymph nodes are 2 cm. below the skin surface, the mucosa of the

TABLE III: COMPARISON OF DEPTH DOSES WITH VARIOUS RADIATION TECHNICS*

Method	D	D ₁	D ₂	D ₄	D ₆	D ₈
Two opposing portals		4,000†	5,000	5,000	4,670	5,000
Single portal		8,000	7,450	6,080	4,670	3,750
Grid: open	15,000	16,350	13,800	10,050	7,200	5,250
Grid: closed	15,000	3,300	4,200	4,050	3,450	3,000

* Depth dose data from Johns (8). Grid dose data from Sopp (4).

† Exit dose omitted.

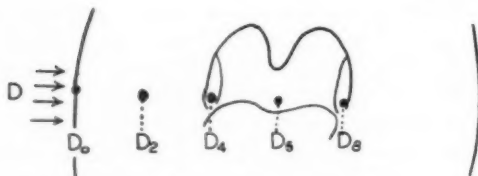


Fig. 8. Diagrammatic representation of coronal section of the lower head. Each number represents the depth below the surface of a point of interest.

ipsilateral tonsil is 4 cm. deep, the mid-line (uvula) is 6 cm. deep, and the contralateral mucosal surface is 8 cm. deep. The comparative depth doses for three irradiation techniques are shown in Table III. With two opposing portals and a skin dose of $2 \times 4,000$ r (with back-scatter) in four to six weeks, the depth dose at each tonsillar mucosa is 5,000 r. This usually produces a second-degree epithelitis. When a skin dose of 8,000 r (with back scatter) is delivered to a single open-portal, the dose to the contralateral mucosa at 8 cm. depth is approximately 3,750 r. There was never a second-degree epithelitis of the contralateral mucosa from this dose.

Using the median administered dose with the grid, *i.e.*, 15,000 r (air), the tissue dose at the contralateral mucosal surface is 5,250 r maximum and 3,000 r minimum. A second-degree epithelitis occurred in one-third of the cases.

To recapitulate: A tissue dose of 5,000 r (from two opposing portals) usually produces second-degree epithelitis; whereas 3,750 r (single open portal) does not. With the grid, second-degree epithelitis is produced in one-third of the cases when the measured tissue dose in 5,250 r maximum and 3,000 r minimum.

These findings suggest that measured dosages through a grid are approaching reasonable accuracy.

SUMMARY AND CONCLUSIONS

A comparative study of the "grid" vs. the "open-portal" technic was made by irradiating, through one field, two groups of patients having squamous-cell cancer of the head and neck. The size of the portals and overall treatment times were similar.

The doses for each technic were grouped in a higher and a lower dose range. Similar severe maximum skin reactions were produced by: 7,100 to 8,000 r (measured with back-scatter) with the open-portal technic and 15,100 to 20,000 r (air) with the grid. A lower grade of skin reaction was produced by dose levels of 6,100 to 7,000 r (measured with back-scatter) for the open-portal and 10,100 to 15,000 r (air) for the grid technic.

With doses producing similar skin reactions, the grid technic delivered larger effective doses in the depth, as confirmed by the following clinical observations: (a) At the higher dose levels, the open-portal technic produced second-degree epithelitis in only 7 of 16 cases, whereas the grid produced it in 12 of 13 cases. (b) At the lower doses levels, the open-portal method produced second-degree epithelitis in only 3 of 13 cases, whereas the grid produced it in 16 of 20 cases. (c) The single open-portal technic never produced bilateral epithelitis, whereas the grid technic produced it in 11 of 33 patients.

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SUMMARIO IN INTERLINGUA

Irradiation de Avantiatare Cancere del Capite e del Collo a Transverso un Grillia. Parte I: Studio del Dose Absorbite, per Observationes del Reaction in Pelle e Membrana Mucose

Un studio comparative del technicas a "grillia" e a "porta aperte" esseva facite per irradiar via le mesme campo duo grupos de patientes con cancro a cellulas squamose in le capite e le collo. Le magnitudine del portas e le tempores total de tractamento esseva simile. Le grillia habeva perforationes de 1 cm², e 45 pro cento del area esseva aperte.

Le dosages usate con le un e con le altere del duo technicas esseva gruppate in un ordine superior e un ordine inferior. Simile reactions cutanee de severitate maximal esseva producite per (1) 7.100 a 8.000 r (mesurate con diffusion retrorse) in le caso del technica a porta aperte e (2) 15.100 a 20.000 r (aere) in le caso del technica a grillia. Un plus basse grado de reaction cutanee esseva producite per doses (1) al nivellos de 6.100 a 7.000 r (mesurate con diffusion retrorse) in le caso del technica a

porta aperte e (2) al nivellos de 10.000 a 15.000 r (aere) in le caso del technica a grillia.

Con dosages producente simile reactiones cutanee, le technica a grillia deliverava plus grande doses efficace al profunditate. Iste assertion se basa super le sequente observationes: (a) Al plus alte nivellos de dosage, le technica a porta aperte produceva epitheliitis del secunde grado in solmente 7 ex 16 casos, durante que le technica a grillia produceva lo in 12 ex 13 casos. (b) Al plus basse nivellos de dosage, le technica a porta aperte produceva epitheliitis del secunde grado in solmente 3 ex 13 casos; le technica a grillia, in 16 ex 20 casos. (c) Le technica a porta aperte nunquam produceva bilateral epithelitis del secundo grado, durante que le technica a grillia produceva lo in 11 ex 33 patientes.



Salmonella Bacteremia: A Case with Miliary Lung Lesions and Spondylitis¹

R. H. GREENSPAN, M.D., and S. B. FEINBERG, M.D.

ALTHOUGH PULMONARY and bony manifestations of salmonellosis have been reported with some frequency, no example of miliary lung lesions due to this cause could be found in the literature. Felson mentioned *Salmonella* in his review of acute miliary diseases of the lung, but states that the reported cases did not show a true miliary appearance. The following case of miliary lung lesions in association with *Salmonella* bacteremia and osteomyelitis of the spine should therefore be of interest.

A 66-year-old white housewife entered Mt. Sinai Hospital on June 16, 1955, one day after the onset of her first bout of excruciating lumbar pain. Although she was acutely ill, localizing physical findings were limited to a rigid back, the result of muscle guarding. There was abdominal distention due to ileus.

The admission chest film (Fig. 1) showed a coarse miliary pattern bilaterally. The lesions, 1 to 3 mm. in diameter, exhibited the roentgen appearance of a typical hematogenous spread. The initial spine film showed normal bones, with intestinal distention due to adynamic ileus. The temperature was 101.2° F., pulse 100, and respirations 24 per minute. Initial blood studies were normal. The erythrocyte sedimentation rate was 73 mm. in an hour. Urinalysis showed 20 white blood cells per high-power field and was otherwise normal. Blood chemistry, including values for Cl, CO₂, Na, K, Ca, P, alkaline phosphatase, bilirubin, and serum protein, was normal. Bromsulfalein retention was 33 per cent in forty-five minutes, and blood urea nitrogen was 31 mg. per 100 c.c., returning to normal after hydration. Tuberculin and histoplasmin tests were negative.

After blood, stool, urine, and sputum cultures were obtained, tetracycline, 250 mg., four times a day, was administered and parenteral fluids were given to maintain adequate hydration and nutrition. There was no response to therapy. Five days after admission, blood cultures showed *Salmonella*, which was identified as Type C 1, *Salmonella Tennessee*, sensitive to chloramphenicol *in vitro*. This drug was given in doses of 500 mg. four times a day. Improvement was rapid, with return to normal temperature, diminution of back pain, and slight decrease in the size of the miliary chest lesions. The

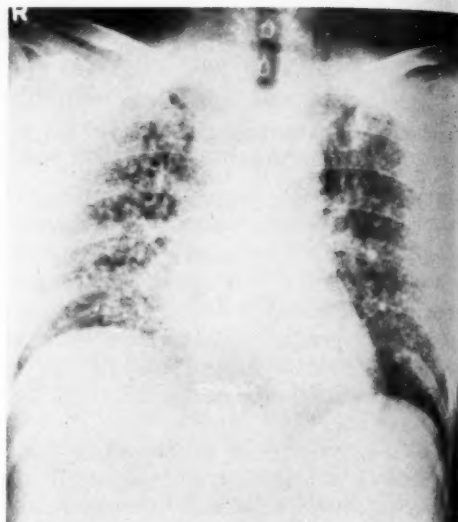


Fig. 1. Admission chest film showing bilateral hematogenous ("miliary") dissemination of *Salmonella septi-cemia*. The magnification of the parenchymal lesions was due to the fact that the radiograph was taken in the supine position at 36 in. T.F.D.

sedimentation rate, however, remained high, 100 mm. in an hour.

The patient was discharged on July 9, but back pain on motion persisted and she was readmitted a week later. For the first time, abnormalities in the vertebrae were found (Fig. 2), consisting of destruction of the bone of the opposing plates of L2-3 with collapse of the disk space of the type common to an inflammatory process. Blood cultures were negative at this time, but treatment with chloramphenicol was reinstituted.

On July 29, the patient was transferred to the University of Minnesota Hospitals. Examination revealed local tenderness to percussion over the mid-lumbar spine. The sedimentation rate was 103 mm. in an hour, the A/G ratio was 2.8/3.2, and the stools were positive for occult blood. Urine, gastric, duodenal and blood cultures were negative, but the stools were positive for *Salmonella*, and chloramphenicol was continued. In three weeks the organisms became resistant *in vitro*, and oxytetracycline was substituted. Radiographic evidence (Fig. 3) of chest and spine improvement was obvious, and clinical progress

¹ From the Department of Radiology, Mt. Sinai and University of Minnesota Hospitals, Minneapolis, Minn. Accepted for publication in December 1956.

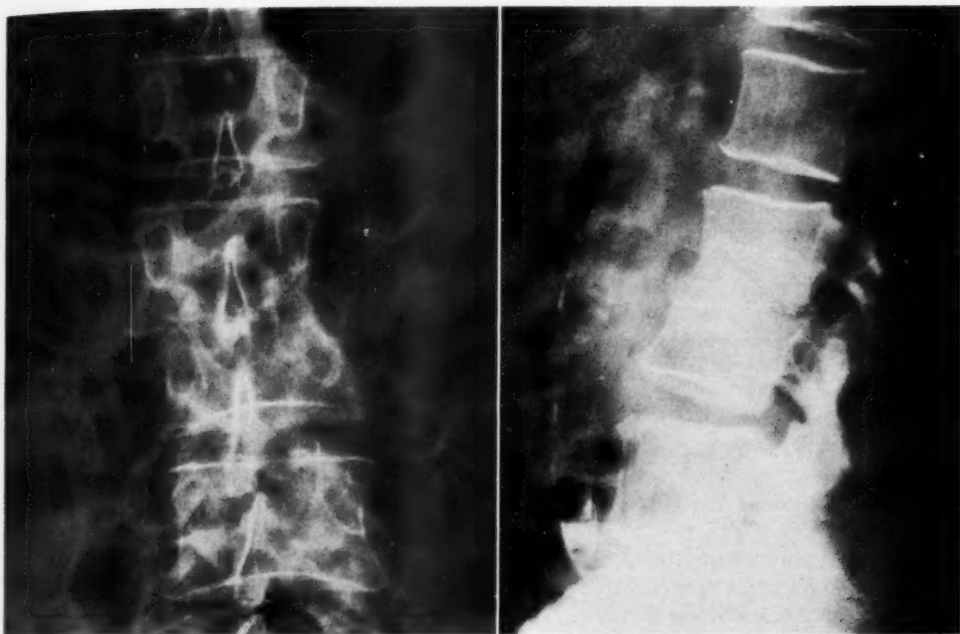


Fig. 2. At the time of the patient's second hospital admission, one month after the first examination, early destructive changes of the adjacent vertebral plates of L2-3 were noted on an intravenous pyelogram. These anteroposterior and lateral spine views taken a week later show complete disk space collapse with vertebral plate destruction at L2-3.

was gratifying. Twelve weeks after the onset of disease, the patient was discharged as an asymptomatic carrier.

Follow-up roentgenograms showed further vertebral healing and regression of the chest lesions to a residual granular pattern. The patient was rehospitalized in three months in an attempt to convert her to a non-carrier, but penicillin and probenidic failed. Because of the presence of biliary calculi a cholecystectomy was done in February 1956, and both the bile and calculi were positive for *S. Tennessee* on culture. T-tube drainage and multiple antibiotic therapy were instituted, and two weeks after a course of neomycin, 2 gm. daily, nine months after onset of the illness, stool cultures became negative and remained so.

SUMMARY

A case of *Salmonella* bacteremia with miliary lung lesions and osteomyelitis of the spine has been presented. To our knowledge this condition has not been reported previously.

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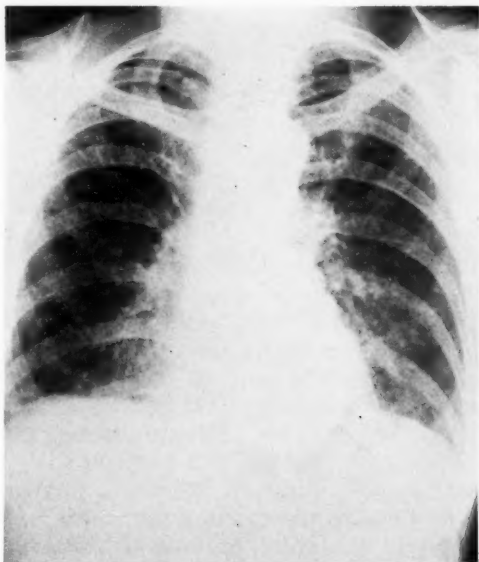


Fig. 3. Postero-anterior teleroentgenogram of chest taken three months after the onset of illness, showing partial clearing of the miliary pattern.

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SUMMARIO IN INTERLINGUA

Bacteremia a *Salmonella*: Un Caso con Lesiones Miliari in le Pulmones e con Spondylitis

Es reportate un caso de bacteremia a *Salmonella* con lesiones miliari in le pulmones e con osteomyelitis del columna vertebral. In un revista del litteratura le autores non ha succedite a trovar ulle altere caso de morbo miliari del pulmones debite a iste causa.

Le roentgenogramma thoracic revelava le grossier miliaritate bilateral que es typic de dissemination hematogene. Le lesiones vertebral consisteva in le destruction del

placas opponite de L2 a L3 con collapsu del spatio discal.

Sub therapia antibiotic le stato del patiente se meliorava clinicamente, e le roentgenogramma indicava un melioration del lesiones vertebral e pulmonar. Le organismos dispareva finalmente post le execution de cholecystectomy (pro calculos bilateral), sequite per drainage a tubo in T e le administration de antibioticos multiple.



Trigonocephaly¹

PAUL A. RIEMENSCHNEIDER, M.D.

TRIGONOCEPHALY is an obvious, relatively uncommon deformity of the skull characterized by a triangular, pointed, frontal bone. Perhaps because of the peculiar shape of the skull, this condition has been classified by several authors with the various types of premature closure of

seems an unlikely one, since the deformity associated with premature synostosis consists of a shortening of the diameter of the skull at right angles to the plane of the closed suture and an increased diameter at right angles to the plane of the open sutures rather than a point deformity.

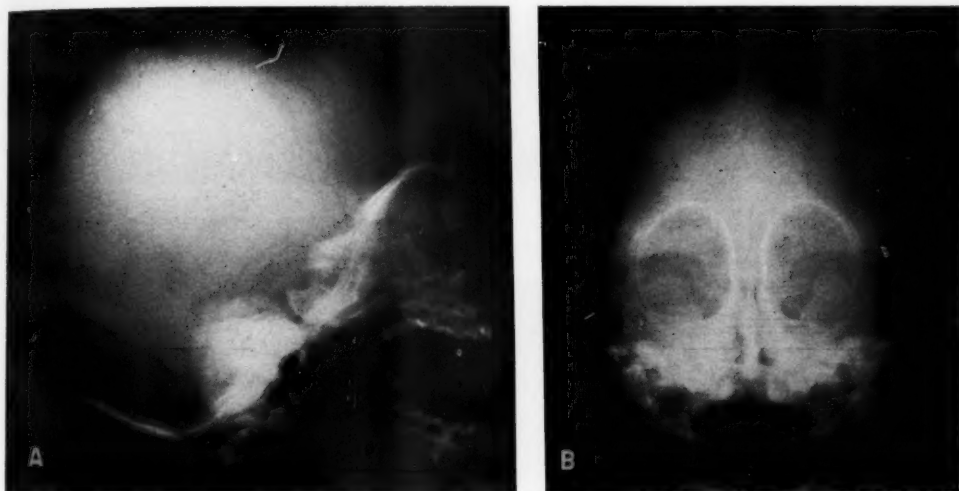


Fig. 1. Patient M. W. A. Lateral skull view. There are noticeable shortening of the anteroposterior diameter of the frontal bone and shallowness of the anterior fossa.

B. Anteroposterior view of skull. The orbits are extremely close together. The metopic suture is open.

the cranial sutures (3), being ascribed to intrauterine closure of the metopic suture. A thoughtful consideration of the shape of the skull, however, tends to suggest other conclusions, for none of the varieties of premature closure of cranial sutures is characterized by a keel-like deformity at the site of the closed suture. Welcker's (1, 4) anatomical diagram shows the metopic suture of his patient open.

Greig (2) regarded the deformity as the result of an open metopic suture with increased intracranial pressure and closed sutures elsewhere. This conclusion also

Caffey (1) and others report that the underlying deformity is a hypoplasia of the frontal lobes.

The purpose of this paper is to present the roentgen appearance of the skulls of two patients with this deformity, to call attention to several associated anomalies, and to attempt to separate this deformity from the category of premature closure of the cranial sutures.

The two sets of films reproduced show a strikingly similar picture. The actual keel deformity is demonstrated only in a submentovertical projection. Both skulls

¹From the Department of Radiology, Syracuse Memorial Hospital and the State University of New York, Upstate Medical Center, Syracuse, N. Y. Accepted for publication in December 1956.

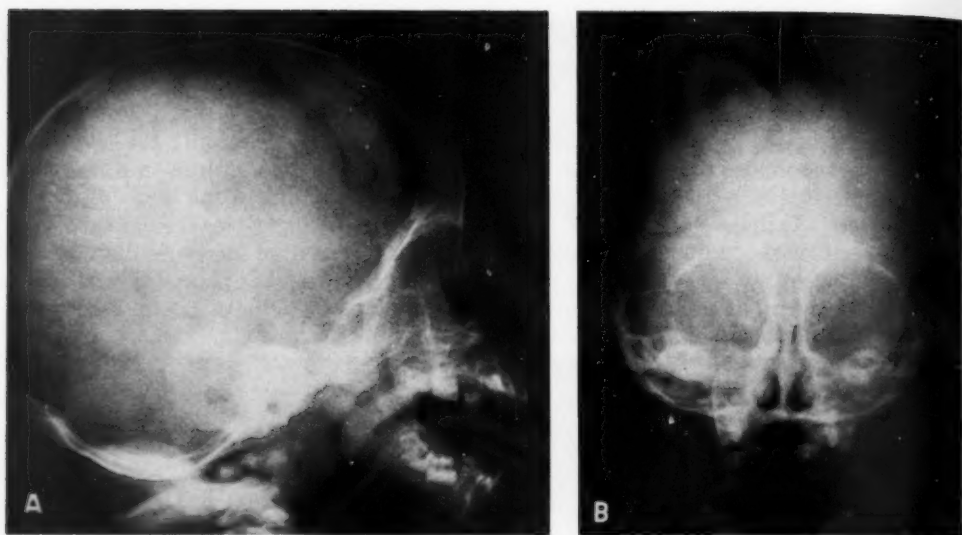


Fig. 2. Patient R. B. A. Lateral view of skull. Note the marked similarity to Fig. 1. B. Anteroposterior view. The metopic suture is closed.



Fig. 3. Patient R. B. Submentovertical projection. The extreme keel-like deformity at the site of the metopic suture is evident.

have a markedly shortened measurement of the frontal bone in the anteroposterior direction, with a shallow frontal fossa.

The orbits are extremely close together, suggesting a hypoplasia of the ethmoid bone. One skull shows a closed metopic suture, while in the other patient this suture remains open.

The findings of a hypoplasia of both frontal and ethmoid bones of the skull in the presence of this deformity supports the hypothesis that the underlying deformity is a hypoplasia of the frontal lobes and that this abnormality is in no way related to the group of deformities characterized by premature closure of one or more cranial sutures.

SUMMARY

1. Trigonocephaly is a congenital deformity of the skull characterized by a keel-like ridge at the site of the metopic suture.

2. Skull films of two patients with this deformity are presented, showing, in addition, small frontal bones and orbits set closely together. The metopic suture was closed in one patient and open in the other patient.

3. These changes discount the hypothesis that trigonocephaly is a result of intrauterine closure of the metopic suture and support the conclusion that the under-

lying cause is a hypoplasia of the frontal lobes.

NOTE: Our appreciation is extended to Dr. Theodore Perl for permission to use the films of patient R. B.

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SUMMARIO IN INTERLINGUA

Trigonocephalia

Trigonocephalia es un deformitate congenite del cranio, characterisate per un cresta cariniforme al sito del sutura metopic. Certe autores ha attribuite lo a clausura intrauterin del sutura metopic, sed observationes in le duo hic reportate casos invalida ille theoria e supporta le conclusion que le causa subjacente es un hypoplasia

del lobos frontal. In ambe casos, roentgenogrammas demonstrava hypoplasia del ossos frontal e ethmoide, con le orbitas proximissime le un al altere. Le sutura metopic esseva aperte in un del patientes e claudite in le altere. Le deformitate cariniforme es vermente demonstrabile solmente in le projection submentovertical.



Cystitis and Ureteritis Emphysematosa¹

C. SOTEROPOULOS, M.D., E. KAWASHIMA, M.D., and JOHN H. GILMORE, M.D.

SEVERAL ARTICLES have appeared recently regarding cystitis emphysematosa, indicating the increasing interest in this entity and showing the value of early diagnosis and treatment. So far as we are aware, however, the complication of ureteritis emphysematosa has not been reported previously.

CASE REPORT

A 68-year-old white woman with poorly controlled diabetes was admitted to the hospital for gastrointestinal study because of vague abdominal complaints, diarrhea, weakness, and anemia. On the day of the gastrointestinal examination, nausea and vomiting developed and the gallbladder was found to be filled with calculi. The patient improved under conservative management, but two days later experienced sudden lower abdominal pain with urgency and frequency. A tender mass, which proved to be a distended urinary bladder, was palpated in the lower abdomen. The patient was sent to the x-ray department with a clinical diagnosis of "acute abdomen."

Roentgenograms showed the characteristic findings of cystitis emphysematosa, with extension of the changes into the distal thirds of both ureters (Fig. 1). In the decubitus view a large fluid level was seen in the urinary bladder. After evacuation, the radiolucent zone followed the contraction of the wall of the bladder (Figs. 2 and 3). A roentgenogram of the abdomen forty-eight hours later showed no evidence of abnormality.

Catheterization yielded bloody urine. Culture of the urine specimen yielded a growth of *B. coli* and *aerogenes*. Non-protein nitrogen was 28 mg. per 100 c.c. The blood sugar was 332 mg. per 100 c.c. The white cell count was 12,500; hemoglobin 11.0 gm. The urine output decreased for a period of two days to approximately 400 c.c. daily. The temperature was 100.5° for four days.

The patient improved rapidly after receiving antibiotics and fluids intravenously. Cystoscopy, after two and a half weeks, showed an intensely red bladder mucosa with many rugae and an abundance of tenacious clots and mucous material.

A second cystoscopic study two weeks following the first revealed a "persistent red, edematous area the size of a dollar, having the appearance of residual inflammatory reaction." A cholecystectomy was performed, and the patient was discharged a month and a half later in good condition.

¹ Accepted for publication in December 1956.



Fig. 1 Supine roentgenogram. The urinary bladder is distended and the radiolucency of its wall is clearly seen, due to gaseous vesicles. The radiolucency extended into the distal portions of both ureters, as shown on the original films. Gallstones are present.

DISCUSSION

The pathogenesis of cystitis emphysematosa has been covered in recent articles and need not be discussed here. Our patient presented a clinical course and roentgenographic findings similar to those previously reported. The cause of the infection was found on urine culture. The response to treatment was remarkable. The marked improvement of the condition in twenty-four hours shows again the value of early diagnosis.

The unusual feature of the case is the extension of the changes in the bladder wall into the ureters. Anatomically the mucous membrane of the ureter is continuous with the mucous membrane of the urinary bladder and resembles it. Thus the gaseous vesicles in the inflamed vesical mucosa may easily extend into the ureter. Why this extension is not more commonly seen is not obvious, though several possible

explanations are suggested in the following paragraphs.

The course of this case lends support to a theory expressed by Taussig in 1907, that the gas-producing capacity of *B. coli* might be associated with a developmental phase of the organism. Thus the appearance of gaseous vesicles is limited to a certain stage of the infection. The clinical course of our patient is in agreement with this theory.



Fig. 2. Right decubitus view. A long fluid level in the urinary bladder is shown in part.

A roentgenogram of the abdomen forty-eight hours after the discovery of the disease failed to reveal any gaseous vesicles. The mucosal inflammation, however, subsided less rapidly, and cystoscopy two and a half weeks after the demonstration of the cyst-like changes showed an intensely red bladder mucosa. Faingold, Hansen, and Rigler (1) also mentioned the transient nature of the condition as demonstrated roentgenologically.

Schönberg (8), in 1913, was able to show that the capacity of bacteria of the *coli* group to produce gas decreased with time. It depends, therefore, upon the stage of the inflammation at the time of the x-ray examination whether or not gaseous vesicles will be visualized. This may account in part for the fact that ureteritis emphysematosa has not been reported more frequently.

The functional capacity of the ureterocystic junction to prevent regurgitation



Fig. 3. Supine roentgenogram after evacuation of the bladder. The radiolucent line follows the contraction of the bladder wall.

into the ureters may exert a similar effect on extension of gaseous vesicles from the mucosa and submucosa of the urinary bladder into the ureters. In addition, it is interesting to postulate that the formation of gas vesicles in the mucosa of the distal ureters would decrease the otherwise narrow lumen (1-5 mm.) and produce an incomplete, transient obstruction. The slight elevation of non-protein nitrogen in this case seems to be indicative of such a transient obstruction, since on the patient's discharge from the hospital the figure had fallen to 25. While this may be questioned, since the non-protein nitrogen was at no time excessively high, yet the oliguria during the two days of acute symptoms (400-500 c.c. daily) supports the postulate.

SUMMARY

A case of cystitis emphysematosa complicated by ureteritis emphysematosa is reported.

Roentgenograms showed the characteristic findings of cystitis emphysematosa with extension of the emphysematous changes into the ureters. Forty-eight hours later the gaseous vesicles had dis-

appeared, though mucosal inflammation, as shown cystoscopically, persisted. A mild urinary obstruction was believed to be present.

Because of the transient nature of the emphysematous changes, it is believed that these may actually occur in association with cystitis more frequently than is appreciated. Serial studies during the acute course of the disease might lead to their more frequent recognition.

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SUMMARY IN INTERLINGUA

Cystitis e Ureteritis Emphysematose

Es presentate un caso de cystitis emphysematose complicate per ureteritis emphysematose.

Roentgenogrammas monstrava le constataciones typic de cystitis emphysematose con extension del alterationes a in le ureter. Quaranta-octo horas plus tarde le vesiculas gasose habeva disparite, ben que le inflammation mucosal persisteva.

A causa del natura transiente del alterationes emphysematose, il pare justificate creder que tal alterationes occurre de facto in association con cystitis plus frequentemente que lo que es generalmente recognoscite. Studios serial durante le curso acute del morbo resultarea possibilmente in lor recognition in un plus grande numero de casos.



EDITORIAL

On Questionnaires and Records

"Them that asks no questions isn't told a lie"—Kipling, in *A Smuggler's Song*.

"I will not be baited with *what*, and *why*; what is this? what is that? why is a cow's tail long? why is a fox's tail bushy??"—Samuel Johnson

The radiologist has been subjected to a spate of questionnaires in recent years; and as each new one reaches his desk, he may well, like Sam Johnson, cry out in dismay. A host of detailed items require response, and thick charts may have to be reviewed. Should he bother?

He may reply, as did one respondent, that he hadn't enough information to justify filling out "these 4 pages of quarto." He may, as did another, plaintively suggest that the time involved would suffice for him to write an article himself. Or, in a reflective mood, he may recall wondering about the dangers of a special procedure and finding no precise information available. If this last is his reaction, he will get to the business at hand with dispatch and send off the completed questionnaire with the hope that his collaboration may yield dividends for himself and his patients. There is still another possibility: wanting to co-operate, yet unable to find enough time, he may substitute impressions for fact, and guesses for data.

This issue of RADIOLOGY contains information accumulated from two questionnaires on useful but complicated and potentially hazardous radiologic procedures. Out of my personal experience with one of these questionnaires (1), I am convinced that useful knowledge may accrue from this type of study, but that all such studies must be taken with a grain of salt.

1. Knowledge of the incidence of severe reactions and death in a special procedure permits the radiologist more precisely to

balance risk against indication. In determining technic, he may discard a more for a less hazardous approach, and he may better evaluate the choice and concentration of media. Study of the reactions may suggest to him methods of decreasing the risk and of making the procedure more widely usable.

2. If the foregoing is true, then why take this useful information with a "grain of salt?"

The vast possibilities for inaccurate recording and interpretation of information obtained by the questionnaire method inhere in the questioner, the nature of the data, the respondent, the failures to respond, and the interpretation of the data.

A. *The Questioner*: The bias of the individual who undertakes the study may be vividly reflected in the form and wording of the questions. The questionnaire may be so oriented as to call for predictable replies, recalling the thief who broke into Party Headquarters in Roumania and stole the complete results of next year's elections. Before any questionnaire is circulated generally, it should be tested on a small but varied population in order to evaluate the objectivity and clarity of the questions. This provides the best opportunity of learning whether the questions are understandable and will be productive of useful information.

B. *The Nature of the Data*: In any complicated radiologic procedure, a large number of variables are involved. Pre-medication, anesthesia, injection site,

chemical composition, concentration and volume of the medium, the patient's condition—all of these may or may not play a significant role in severe reactions and death. Any effort to relate one or more of these variables to the incidence of reactions requires a careful formulation of questions. Here, the biostatistician can be helpful. A discussion with him should include the background of the procedure, a description of the variables, the information desired, and the potential usefulness of the accumulated data. This may result in elimination of unnecessary questions, formulation of interrelated questions which are yet not too complicated for the respondent, and eventually in the difference between interpretable, significant results and a useless mass of information.

C. The Respondent: If the person answering the questions is genuinely interested in the results of the questionnaire, he is likely to respond with accurate and detailed information. If he resents the demand on his time involved in gathering the material, or if he is too busy to respond precisely, his answers may be either useless or frankly misleading. One reply from a great center of radiology noted an undue number of hemiplegias following retrograde aortography with 35 per cent Diodrast. Since this was inconsistent with the experience of others, a request was made for a check of the medium used and its concentration. Two weeks later a restatement was received: *all* of the aortograms at this institution had been performed with either 70 per cent Neo-Iopax or 70 per cent Diodrast. In another instance the response indicated that 30 to 35 per cent media only were being employed, and that no deaths had occurred in a large series. Yet the respondent had himself reported in the literature a death following thoracic aortography in which a 70 per cent concentration of the medium was used. Furthermore, earlier reports from the same institution recounted the common use of 70 per cent media in the younger age groups. Again, a death following injection of 35 per cent Diodrast is reported in the

literature; review of this case revealed that a 70 per cent concentration had been employed. Such inaccuracies may significantly alter the validity of the data.

D. The Failures to Respond: A survey is useful in direct proportion to the number of replies received. The larger the experience analyzed, the greater the possibility of canceling out error and avoiding misinterpretation. A number of replies were received which declared that the desired information was simply not available. One institution in which a particular variant of the technic was born and flourished, and in which a number of deaths occurred, described a fascinating series of road-blocks in the way of gathering such information. The "record room" curtain could not be penetrated. This is one indication of the manner in which a sample can be skewed.

E. The Interpretation of the Data: It has been said that statistics are used the way a drunk uses a lamp post: for support rather than light. Certainly, the misuses of statistics are legion when data are analyzed by the inexperienced or the deliberately myopic. The value of consulting an expert in the field lies in his ability to assess the significance of a set of data, and hence the validity of inferences based upon the data. In the material on thoracic aortography, for example, it seems apparent that brachial injection is far safer than carotid or catheter injection. Yet the brachial injections were weighted by a large number of cases in which 30 and 35 per cent media were employed, and therefore were not comparable to the other groups. Carotid and catheter injection could be compared, since there were enough cases in which 70 per cent media were used in both groups; such a comparison demonstrated the increased hazard of the carotid approach.

The experience with the questionnaires serves to emphasize the lack of simple yet complete records of complicated radio-diagnostic procedures in many institutions. The responsibility of university depart-

ments is heavy in this regard, because they represent centers of exploration of new diagnostic methods. Only with adequate records can the hazards and the usefulness of a technic be thoroughly evaluated. When the dangers or innocuousness of a particular procedure become well established, it may be satisfactory to record only the severe reactions. But for such studies as angiocardiology, thoracic and trans-lumbar aortography, intravenous chole-cystography, cerebral and peripheral arte-riography, and retroperitoneal pneumog-raphy, it is essential that a careful record be kept in each instance. By far the best method of doing this is to set up a form containing as complete a check list as may seem desirable, which may then be altered with experience. In the early stages, the form should incorporate every possible item of interest. Unless it is this in-clusive, the material simply will not be there when it is most needed. If this is done for each procedure, and if a simple method of classifying the information is

utilized, the radiologist himself will be far better equipped to analyze his own expe-rience.

Perhaps a helpful forward step in this direction would be the assumption by a committee of the American College of Radiology of the task of screening new radiologic procedures and of constructing a sample record form available to all radiologists. The radiologist could then use or alter this form, as he saw fit, in the gathering of data within his department. Such a committee might serve a useful role as a "clearing house" of accumulated experience; it would permit a more precise appraisal of the relationship of risk to value in each new technic, and a more rapid dissemination of such infor-mation.

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ANNOUNCEMENTS AND BOOK REVIEWS

EXAMINATIONS AMERICAN BOARD OF RADIOLOGY

The Spring 1958 examinations of the American Board of Radiology will be held at the Palmer House, Chicago, Ill., May 19-23, inclusive. The deadline for filing applications is Jan. 1, 1958. Correspondence should be addressed to The American Board of Radiology, Kahler Hotel Building, Rochester, Minn.

NEW YORK ROENTGEN SOCIETY

At a recent meeting of the New York Roentgen Society, the following officers were elected for a period of one year effective June 1, 1957: President, Maxwell H. Poppel, M.D.; Vice-President, John A. Evans, M.D.; Secretary, Harold G. Jacobson, M.D., Montefiore Hospital, 210th St. and Bainbridge Ave., New York 67, N. Y.; Treasurer, Frank J. Borelli, M.D.

PHILADELPHIA ROENTGEN RAY SOCIETY

The Philadelphia Roentgen Ray Society, at its May meeting, elected the following officers for the coming year: President, Marston T. Woodruff, M.D.; Vice-President, Herman C. March, M.D.; Secretary, Roderick L. Tondreau, M.D., Hospital of the University of Pennsylvania, Philadelphia 4, Penna.; Treasurer, Randal A. Boyer, M.D.

TENNESSEE RADIOLOGICAL SOCIETY

At a recent meeting held in conjunction with the State Medical Association Meeting in Nashville, Tenn., the Tennessee Radiological Society elected the following officers for the ensuing year: President, Dr. W. E. Scribner, Kingsport; Vice-President, Dr. David S. Carroll, Memphis; Secretary-Treasurer, Dr. George K. Henshall, 311 Medical Arts Building, Chattanooga. Dr. Herbert C. Francis of Nashville was nominated Councilor to the American College of Radiology and Dr. Walter Hankins of Johnson City, Alternate Councilor.

SOCIETY OF NUCLEAR MEDICINE

The Society of Nuclear Medicine held its annual meeting in the Skirvin Hotel, Oklahoma City, Okla., June 20-22, 1957. Scientific sessions were conducted daily from 8:00 A.M. to 5:00 P.M. The annual banquet was held Friday, June 21.

NATIONAL BUREAU OF STANDARDS NEW RADIATION HANDBOOK

The 1956 recommendations of the International Commission on Radiological Units and Measure-

ments have been published as National Bureau of Standards Handbook 62. This report covers the recommendations of the Commission as agreed upon at its meetings in Geneva in April 1956, and replaces its earlier report issued in 1953. The new report includes an extensive amount of basic information and data necessary to make radiation dose measurements in energy units (rads), and to convert data expressed in roentgens to the equivalent of rads.

Copies of this publication may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., at a cost of 40 cents each.

ADDENDUM TO RADIATION HANDBOOK 60

In a recent statement, the National Committee on Radiation Protection and Measurements (NCRP) presented in brief form its new recommendations on maximum permissible radiation levels (see Radiology 68: 260, February 1957), a revision of those contained in National Bureau of Standards Handbook 59, *Permissible Dose from External Sources of Ionizing Radiation*. The introduction of these new working levels makes necessary the revision of some of the Committee's other recommendations, which are also published in the NBS Handbook Series. These deal with various phases of radiation protection such as monitoring methods, disposal of wastes, the safe handling of isotopes, and radiation legislation.

Until detailed revisions can be completed, corrective statements are being prepared for each of the handbooks, indicating the changes needed to comply with the new maximum permissible levels. The first such statement, for Handbook 60, *X-Ray Protection*, has been completed. Holders of this Handbook may obtain copies of the addendum by addressing a request to the National Bureau of Standards, Editorial and Printing Section, Washington 25, D. C.

DR. PAUL C. AEBERSOLD

Dr. Paul C. Aebersold, who has been Director of the Atomic Energy Commission's Isotopes Extension at Oak Ridge, Tenn., has been transferred to the Commission's Washington headquarters as Assistant Director for Isotopes and Radiation, Division of Civilian Application.

Dr. Aebersold will be responsible for the Commission's program for distribution of radioisotopes, development of radiation protection criteria for licensing radioactive materials, and cooperation with the state governments and other Federal agencies relative to controls and regulations for nuclear materials.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

RADIATION: WHAT IT IS AND HOW IT AFFECTS YOU. By JACK SCHUBERT and RALPH E. LAPP. A volume of 314 pages. Published by The Viking Press, New York, 1957. Price \$3.95.

MANUAL OF RADIATION THERAPY. By K. WILHELM STENSTROM, Ph.D., Professor of Biophysics; Director, Section of Radiation Therapy, University of Minnesota Medical School. Collected by John B. Coleman, M.D., Clinical Instructor in Radiology. Revised with Additions and Discussions by Paul C. Olfelt, M.D., Clinical Instructor in Radiology, and Frances Conklin, M.D. A volume of 94 pages, with 2 figures, 1 chart, and 2 tables. Published by Charles C Thomas, Springfield, Ill. Price \$4.50.

TRILINEAR CHART OF NUCLIDES. By WILLIAM H. SULLIVAN, Oak Ridge National Laboratory. Revised Artwork by Hildegard Nemetz from originals by Kay Benscoter. Four pages of text, plus charts. Published by Oak Ridge National Laboratory Operated by the Union Carbide Nuclear Co. for United States Atomic Energy Commission. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Second edition, 1957. Price \$2.00.

DIE PROGNOSE DER WIRBELSÄULENLEIDEN. EINE BERUFSPROPHYLAKTISCHE BETRACHTUNG. By PROF. DR. J. E. W. BROCHER, Geneva. A volume of 68 pages, with 45 illustrations on 33 figures. Published by Georg Thieme Verlag, Stuttgart, Germany, 1957. Distributed in the United States and Canada by Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 12.80 (\$3.05).

KURVEN UND TABELLEN FÜR DIE STRAHLENTHERAPIE. By DR. FELIX WACHSMANN, Privat-Dozent für medizinische Physik, Universität Erlangen, Erlangen, Germany, and Dr. ALEXANDER DIMOTIS, zur Zeit wissenschaftlicher Assistent, Universität Erlangen. (Jap. and English, French, and Spanish.) A volume of 184 pages, with numerous charts and tables. Published by S. Hirzel Verlag, Stuttgart, Germany, 1957. Price DM 28.—

DIE HÜFTNAHEN FEMUROSTEOTOMIEN UNTER BERÜCKSICHTIGUNG DER FORM, FUNKTION UND BEANSPRUCHUNG DES HÜFTGELENKES. By Priv.-Doz. Dr. Med. MAURICE EDMOND MÜLLER, Zürich.

With a Foreword by Prof. Dr. M. R. Francillon, Zürich. A volume of 184 pages, with 376 illustrations on 282 figures. Published by Georg Thieme, Stuttgart, Germany, 1957. Distributed in the United States and Canada by Intercontinental Medical Book Corporation, New York, 16, N. Y. Price DM 49.50 (\$11.50).

RETROPNEUMOPERITONEUM UND PNEUMOMEDIASTINUM. By Prof. Dr. UMBERTO COCCHI, Zürich. With a Foreword by Prof. Dr. H. R. Schinz, Zürich. Fortschritte auf dem Gebiete der Röntgenstrahlen und der Nuklearmedizin, Ergänzungsband 79. A volume of 226 pages, with 285 illustrations included in 142 figures. Published by Georg Thieme Verlag, Stuttgart, Germany, 1957. Distributed in United States and Canada by Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 67.50 (\$17.85).

Book Reviews

THE HEAD AND NECK IN ROENTGEN DIAGNOSIS. By EUGENE P. PENDERGRASS, M.D., Professor of Radiology and Chairman of the Department of Radiology, University of Pennsylvania; J. PARSONS SCHAEFFER, M.D., Ph.D., Professor of Anatomy and Director of the Daniel Baugh Institute of Anatomy, Emeritus, Jefferson Medical College; PHILIP J. HODES, M.D., Professor of Radiology, University of Pennsylvania. Two volumes of 1,826 pages, with 2,403 illustrations. Published by Charles C Thomas, Springfield, Ill. Second edition, 1956. Price \$37.50.

In this revision of a classic text those interested in problems of the head and neck will recognize an old and trusted friend, changed to be sure, but for the better. This second edition has been largely rewritten and expanded. As in the original work, the collaboration of a noted anatomist assures a sound anatomic background for the roentgen studies. This is of unusual benefit in evaluating studies of the head and neck.

The work begins with a section devoted to the normal anatomy of the skull and its variations, together with developmental changes. This is followed by descriptions of general disease processes, injuries, tumors, etc. Subsequent chapters are devoted to considerations of the various component parts of the head and neck. Special examination methods such as cerebral pneumography and angiography are dealt with extensively. The clinical aspects associated with the lesions under discussion are included throughout and constitute a valuable part of the text.

Abundant illustrations, including well chosen radiographs and photographs, enhance the descriptive material. A bibliography is appended to each chapter. A complex index contributes to the reader's convenience.

This work will, of course, be of most value to

radiologists but all the special surgical groups dealing with lesions in the areas discussed will find it helpful. It is thus recommended, also, to neurologists, internists, and dentists.

THE YEAR BOOK OF RADIOLOGY (1956-57 YEAR BOOK SERIES). RADIOLOGIC DIAGNOSIS, edited by JOHN FLOYD HOLT, M.D., Professor, Department of Radiology, University of Michigan, and FRED JENNER HODGES, M.D., Professor and Chairman, Department of Radiology, University of Michigan. RADIATION THERAPY, edited by HAROLD W. JACOX, M.D., Professor of Radiology, College of Physicians and Surgeons, Columbia University, and Chief, Radiation Therapy Division, Radiologic Service, Presbyterian Hospital, New York City, and MORTON M. KLIGERMAN, M.D., Associate Professor of Radiology, College of Physicians and Surgeons, Columbia University, and Associate Attending Radiologist, Presbyterian Hospital, New York City. A volume of 430 pages, with 361 figures. Published by the Year Book Publishers, Inc., 200 East Illinois Street, Chicago, Ill., 1957. Price \$9.00.

The twenty-fifth Year Book of Radiology opens appropriately with a reprint of an editorial on the "Debt of Surgery to Roentgenology," from the *American Journal of Roentgenology*. Beyond this it follows the plan of earlier volumes, with a brief section on Technical Developments followed by well chosen abstracts on Diagnosis and Therapy appropriately classified and annotated.

So well established is the high character of this work that little need be said by way of review. It comprises in the scope of a single volume the essence of the radiologic literature for the period covered, June 1955 through June 1956.

ATLAS OF TUMORS OF THE NERVOUS SYSTEM. By H. M. ZIMMERMAN, M.D., Chief, Laboratory Division, Montefiore Hospital, and Professor of Pathology, College of Physicians and Surgeons, Columbia University, New York City; MARTIN G. NETSKY, M.D., Associate Neuropathologist and Associate Attending Physician in Neuropsychiatry, Montefiore Hospital, New York City, presently Professor of Neuropathology and Associate Professor of Neurology, Bowman Gray School of Medicine of Wake Forest College, Winston-Salem, N.C.; LEO M. DAVIDOFF, M.D., Attending Neurological Surgeon, Montefiore Hospital, and Professor and Chairman, Department of Surgery, Albert Einstein College of Medicine, New York City. A volume of 192 pages, with 277 illustrations including roentgenograms, photographs, photomicrographs, and drawings (233 in color). Published by Lea & Febiger, Philadelphia, 1956. Price \$25.00.

In this monograph the authors present the morphologic features of tumors of the nervous

system, central and peripheral, discussing the incidence, localization, treatment, prognosis, etc. The text is relatively brief and the great value of the book stems from the wealth of illustrations, which include photographs, drawings, photomicrographs, and radiographs. It is seldom that one sees over two hundred colored illustrations in a book of 192 pages.

This work should appeal to neurosurgeons, neurologists, pathologists, and radiologists.

ADVANCES IN CANCER RESEARCH. Volume IV. Edited by JESSE P. GREENSTEIN, National Cancer Institute, National Institutes of Health, U. S. Public Health Service, Bethesda, Md., and ALEXANDER HADDOW, Chester Beatty Research Institute, Royal Cancer Hospital, London, England. A volume of 416 pages, with tables and graphs. Published by Academic Press, Inc., New York, 1956. Price \$10.00.

This is the fourth in an annual series of reports on late developments in cancer research. The emphasis in this volume is on chemistry. The first paper deals with chemotherapy of cancer in man, particularly acute leukemia in children, and the second paper goes on to chronic leukemias. Studies on tumor immunity through homograft reactions are described. Basic research work on inductive tissue interaction in development and on lipids in cancer are discussed. The last chapter, on the hormonal genesis of mammary cancer, describes experiments which bring out the importance of the various factors causing mammary tumors in mice and rats. Each chapter is followed, as in the preceding volumes of the series, by an extensive bibliography. The studies reported are of a basic nature and will be of interest to research workers in the field.

DIE RÖNTGEN-UNTERSUCHUNG DES HERZENS UND DER GROSSEN GEFÄSSE. VORTRÄGE DES I. BONNER RÖNTGENOLOGISCHEN WOCHENENDKURSUS. By R. JANKER, F. GROSSE-BROCKHOFF, R. HAUBRICH, H. LOTZKES, A. SCHAEDE, and H. HALLERBACH. A volume of 230 pages, with 249 illustrations. Published by W. Girardet, Wuppertal, Germany, 1955. Price \$8.75.

A two-day week-end course on roentgenology of the heart and great vessels was first given at Bonn, Germany, in October 1954, and was repeated in March 1955, when it was scheduled for further repetition. This volume, which was prepared for those taking the course, and to indicate to others the current methods of radiographic examination of the heart, provides in seven chapters the lecture material plus some descriptive roentgenograms.

The available radiographic methods of examining the heart are given in the first lecture by Dr. Janker. On the principle that every possible method cannot be used on any one case, fluoroscopy is indicated as the basic procedure. When combined with ortho-

diagraphy, it is the most economical. Telefilms, body-section methods, and the newer procedures are included.

In the second lecture, Dr. Grosse-Brockhoff, takes up the correlation of the clinical findings, particularly those of ordinary physical examination, the electrocardiographic observations, and the roentgen examination. Not only is cardiac physiology presented, but also a group of typical cardiac abnormalities, including pericardial disease, cardiac dilatation, congenital heart disease and hypertensive heart disease.

The third subject is electrokymography. This has apparently found great favor at Bonn. In Dr. Haubrich's hands, it is routinely combined with electrocardiography and is in the process of replacing roentgenkymography. The procedures of cardiac catheterization and of angiocardiology are briefly presented from a technical point of view by Dr. Hilde Lotzkes. The interpretation of the x-ray findings in terms of acquired and congenital heart disease is written up in greater detail by Dr. Schaede.

The final lecture, by Dr. Hallerbach, provides practical examples in which emphasis is on the choice of the examination to be used to determine the correct diagnosis. Presumably these examples vary from time to time, dependent upon the material available for that particular course. A brief paragraph at the end of the book describes the motion pictures of cardiac action which are shown as an integral part of the course. Most of these films are taken by photography of the fluoroscopic screen. A few of the sequences are obtained by matching rapidly exposed serial films.

DIAGNOSTIC DIFFÉRENTIEL RADIOLOGIQUE DES ULCÉRATIONS GASTRIQUES. By GEORGES CANDARDJIS. With prefaces by Dr. P. Porcher and Pr L. Babaïantz. A monograph of 188 pages, with 92 figures and 6 tables. Published by Masson & Cie, 120, Boulevard Saint-Germain, Paris-6^e, 1956. Price 1,500 fr.

This little monograph is an attempt to evaluate the radiologic principles in the diagnosis of gastric ulcerations on the basis of a review of all the patients operated upon for gastric ulcerations in a five-year period in the University of Lausanne. The series included 108 cases of benign ulcer, 16 cases of ulcer with malignant degeneration, and 9 cases of frankly malignant ulcers (ulcerated exophytic cancers were excluded).

The work is divided into two parts. The first includes chapters on the technic of the radiological

examination and the significance of radiologic signs. The second part includes critical studies on benign ulcers, pyloric stenosis, the meniscus, atypical malignant ulcers, rare causes of gastric ulceration, degenerated ulcers, criteria of malignancy, therapeutic tests, and evolution of gastric cancer.

The author takes issue with a widespread concept that only serial examinations of a gastric lesion will determine whether it is malignant or benign. This decision can often be reached on the first examination if the examiner possesses precise knowledge of radiologic signs and an acute sense of their anatomic counterparts. However, limitations are adequately considered. Shortcomings and even dangers of the therapeutic test are considered.

MICRORADIOGRAFIA OSSEA. SVILUPPO E ACCRESCIMENTO DELLO SCHELETRO UMANO. CRANIO E COLONNA VERTEBRALE. By DOTT. GIORGIO PREVEDI, AIUTO DI RUOLO, and DOTT. MARCO MARCATO, Assistente Straordinario, Istituto di Radiologia e del Radium dell'Università e degli Ospedali Riuniti di Parma, and Istituto di Anatomia Normale dell'Università di Parma. A monograph of 144 pages, with 70 figures. Published by L. Cappelli, Bologna, Italy, 1955.

This monograph is based on a method of microradiography developed by the authors. After considerable experimenting they found that tubes of contact therapy machines (Chaoul or Phillips type) can deliver sufficiently soft x-rays to radiograph very thin specimens. By placing these specimens directly on grainless emulsion plates, in complete darkness, they were able to obtain radiographs of such detail that optical enlargement of 50 to 60 diameters was possible. This result cannot be called true microradiography because finer methods allow a magnification of 100 or 200 diameters. However, the magnification of 50 diameters is sufficient for study of the earliest appearance of nuclei of ossification. Since contact therapy equipment is commonly available, this method is susceptible of widespread application.

The authors have studied the development of the cranial bones and of various segments of the vertebral column in fetuses measuring 100 to 250 mm. In general the results are not different from the accepted embryological findings. However, the radiographs show remarkable detail and the method may be useful in teaching and research. Incidentally, the reviewer has seen this method used to excellent advantage in the radiographic study of minute anesthetized salamanders.



BYRL RAYMOND KIRKLIN, M. D.

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IN MEMORIAM

Byrl Raymond Kirklin, M.D.,

1888-1957

A request to write an obituary notice of Byrl Raymond Kirklin is a challenge. I have accepted it because of my friendship for him, because of my admiration and respect for his attainments, and because of my strong feeling that some of his many accomplishments should be recorded to serve as a stimulus to young radiologists, whom he always championed. Dr. Kirklin represented the finest in his chosen profession. He was active in organized medicine and was a leader in his specialty. He had served as an officer in all of the national radiological societies and was internationally recognized as an authority on roentgenology.

Byrl Kirklin was born in Gaston, Ind., Sept. 22, 1888. He died in St. Mary's Hospital, Rochester, Minn., on March 2, 1957, some sixty hours following a heart attack.

Dr. Kirklin received his M.D. from Indiana University in 1914 and was subsequently granted a Bachelor of Science degree by that institution. He served his internship at the Protestant Deaconess Hospital, Indianapolis, in 1914-15, following which he became interested in radiology. He was resident physician and roentgenologist at the Home Hospital, Muncie, Ind., and practiced his specialty in that city until 1926, except for an interval of war service. In 1922 he was invited by the Mayo Clinic to conduct some special work on roentgen examination of the gallbladder, which he had been pursuing in his Muncie office. The work was successfully completed, and on May 1, 1926, Dr. Kirklin joined the Clinic's Section of Diagnostic Roentgenology. In January 1930, he became head of the Section of Roentgenology, and on July 1, 1948, was appointed Chairman of the Sections of Therapeutic and Diagnostic Roentgenology. He became Senior Consultant in the Section of Diagnostic Roentgenology, on July 1, 1951, and retired on October 5, 1953. Dr. Kirklin was successively instructor in Radiology (1927), Associate Professor (1933), and Professor (1936-53) in the Mayo Foundation Graduate School, University of Minnesota.

It was my good fortune to meet Dr. Kirklin during the First World War, when he was serving as an instructor in the Army X-Ray School at Fort Riley, Kans. During the Second World War, he entered service on May 8, 1943, with the rank of Colonel and was Chief Consultant in Radiology to the Surgeon General. He was released from the Army on Dec. 27, 1945, and was, by the direction of the Secretary of War, authorized to wear the Army Commendation Ribbon. After 1946, he acted as a Consultant in Graduate Education and Radiology

to the Secretary of War, Senior Civilian Consultant in Radiology to the Surgeon General of the Army, and Consultant to the Surgeon General of the United States Air Forces.

Dr. Kirklin was present at the founders' group meeting of the American Board of Radiology in Milwaukee in 1932, and had been Secretary-Treasurer of the Board since its incorporation in 1934. He was Secretary-Treasurer of the Advisory Board for Medical Specialties, Chairman of the Section of Radiology of the American Medical Association in 1936, and a member of the House of Delegates from 1945 until his death; a member of the Council on National Emergency Medical Service and of the Joint Committee for Hospital and Residency Appraisal in 1948; a Fellow of the American College of Physicians; President of the American Roentgen Ray Society in 1937; President of the American College of Radiology in 1942. He was a member of the Radiological Society of North America, the Gastroenterological Association, International College of Radiology, Central Society for Clinical Research, Minnesota Trudeau and Minnesota Radiological Society, of Sigma Chi, Phi Rho Sigma, and Sigma Xi fraternities, and of the Alumni Association of the Mayo Clinic. He held honorary membership in numerous medical societies, including Sociedad Radiología y Fisioterapia de Cuba, Radiological Society of the Republic of Colombia, Sociedad Mexicana de Radiológica y Fisioterapia, Association of Gastroenterologists of Paris, the Royal Society of Medicine of London, the Deutsche Roentgen Gesellschaft, Sociedad Radiológica Panameña, the Academy of Medicine of Muncie (Indiana), Detroit Roentgen Ray and Radium Society, Mississippi Valley Medical Society, St. Louis Medical Society, and the Chicago Roentgen Ray Society. He was an honorary fellow of the International College of Surgeons and a corresponding member of the Academia Nacional de Medicina de Colombia and of the Sociedad Venezolana de Radiología. He served on the Advisory Board of the *Bulletin* of the U. S. Army Medical Department and the editorial board of the *American Journal of Roentgenology*.

Dr. Kirklin wrote many scientific papers during his active medical life. His bibliography lists 210 scientific articles.

The sudden and untimely passing of this outstanding radiologist was a shock to his many friends throughout the world, who will cherish the memory of an educator, organizer, physician, true friend and gentleman. His efforts in behalf of young men will long be remembered by his associates, especially on

the American Board of Radiology. His life and activities should serve as a continuous source of inspiration to those for whose careers he was initially responsible.

Dr. Kirklin has handed on to his son, John,

already a leader in another branch of medicine, a noble heritage. He is survived also by his wife, Gladys Webster Kirklin, a daughter, Mrs. Mary Ladner, three brothers, and a sister.

EDWARD L. JENKINSON, M.D.

A Tribute from the Army Medical Service

We are glad to print the following letter addressed to the Editor of RADIOLOGY from the office of the Surgeon General of the Department of the Army.

To the Editor of Radiology

Dear Dr. Doub:

I am writing to ask if I may, through the courtesy of your journal, pay tribute to the late Dr. Byrl Raymond Kirklin of the Mayo Foundation, for his great contributions to the Army not only during the period of World War II but in the years which followed. His recent death saddens his many friends in the Army Medical Service.

During World War II Dr. Kirklin served as the Senior Consultant in Radiology, Surgical Division,

Office of the Surgeon General of the Army. His wide knowledge of educational facilities throughout the Nation served to formulate the greatly expanded educational and training programs necessary to the war effort. Dr. Kirklin's contributions during the war period are reflected in their lasting effects during the peacetime years, and especially during the Korean conflict.

I express the deep appreciation of the entire Army Medical Service for the professional service and the friendly and personal leadership afforded by Dr. Kirklin in his many years of service to his country.

S. B. HAYS

Major General
The Surgeon General



ABSTRACTS OF CURRENT LITERATURE

ROENTGEN DIAGNOSIS

The Head and Neck

- GREITZ, TORGNV. Rapid Serial Angiography.... 882
- VIETEN, HEINZ. Cerebral Serial Angiography on 70 mm Film Size..... 882
- MOUNT, LESTER A., AND TAVERAS, JUAN M. Cerebral Angiographic Studies Following Surgical Treatment of Intracranial Aneurysms 882
- LINDGREN, E. Another Method of Vertebral Angiography..... 883
- HAUGE, TORMOD. Atrophy Within the Brain Stem Area Following Injection of Thorotrast into the Vertebral Artery..... 883
- VERBIEST, H. Methods of Filling Posterior Fossa and Adjoining Cervical Subarachnoid Space with Small Quantities of Air..... 883
- GILBERTSON, EVA L., AND GOOD, C. ALLEN. Roentgenographic Signs of Tumors of Brain. 884
- OWEN, TREVOR, AND LENCZNER, MICHAEL. Generalized Cysticercosis with Cerebral Infestation..... 884
- FEIRING, EMANUEL H., AND SUSSMAN, BERNARD J. Spontaneous Occlusion of Middle Cerebral Artery..... 884
- GARDNER, W. JAMES, ET AL. Roentgenographic Findings in Trigeminal Neuralgia..... 885
- GARCÍA CASTAÑEDA, MÁXIMO, ET AL. Radiological Anatomy of Temporal Bone..... 885
- GROS, J. Grooved Atrophy of Parietal Bone.... 885
- PSENNER, L. Roentgen Signs of Space-Occupying Lesions of Orbit..... 885
- TAYEBI, HOOSHANG, AND SILVERMAN, FREDERIC N. Congenital Defect of Bony Orbit and Pulsating Exophthalmos..... 886
- KESKEY, G. RICHARD, AND LETSCH, WILLIAM R. Retrobulbar Air Injection with Planigraphy 886
- KOVÁCS, ÁKOS. Headache from Subluxations of the Cervical Articulations..... 887

The Chest

- DOMM, SHELDON, E., ET AL. Bronchography with New Contrast Media..... 887
- BORN, H. G., AND MILLER, D. V. Evaluation of Dionosil as a Bronchographic Agent..... 888
- DERHAM, R. J. Postprimary Intrathoracic Tuberculosis in Childhood, with Special Reference to Its Sequelae..... 888
- BENDER, F. Primary Pulmonary Carcinoma Associated with Active Pulmonary Tuberculosis..... 888
- WEISSMAN, HERMAN. Bronchogenic Carcinoma and Pulmonary Tuberculosis. Problems in Diagnosis with Special Reference to Antituberculous Chemotherapy..... 888
- JONSSON, SIGMUNDUR M., AND HOUSER, JOSEPH M. Scleroderma Associated with Cancer of the Lung..... 889

- FARIÑAS, LAURA, ET AL. Evaluation of Different Radiologic Methods in Diagnosis of Carcinoma of Lung..... 889
- HOCHBERG, LEW A., AND CRASTNOPOL, PHILIP. Primary Sarcoma of Bronchus and Lung.... 889
- DAVIS, EDGAR W., ET AL. Calcification Within Solitary Pulmonary Nodule. A Fallible Sign of Benignity..... 890
- FISSEL, GEORGE E. Acute Fulminating Histoplasmosis..... 890
- DAUZIER, GEORGES, ET AL. Pneumocystis Carinii Pneumonia in Infant..... 890
- DEUTSCH, DAVID L. Kartagener's Triad..... 891
- VERSTEEGH, R. M., AND SWIERENGA, J. Role of Sinusitis in Bronchiectasis..... 891
- SINGLETON, EDWARD B., AND BILES, E. WILEY. Mediastinal Tumors in Children..... 891

The Cardiovascular System

- JANTON, O. HENRY, ET AL. Status of Fifty Patients Four and a Half to Seven Years after Mitral Commissurotomy..... 891
- EASTCOTT, H. H. G., ET AL. Clinical and Radiological Aspects of Diseases of Major Arteries.. 891
- DOWNING, DANIEL F. Congenital Aortic Stenosis: Clinical Aspects and Surgical Treatment..... 892
- STEINBERG, ISRAEL, AND FINBY, NATHANIEL. Angiocardiography in Diagnosis of Saccular Aneurysm of Abdominal Aorta. Case..... 892
- SCHLOSSER, RALPH J., AND HARKINS, HENRY N. Pulmonary Arteriovenous Aneurysm. Six Cases..... 893
- BONNEY, GEORGE. Arterial Disease as a Cause of Pain in Buttock and Thigh..... 893
- MURPHY, THOMAS O., ET AL. Congenital Peripheral Arteriovenous Communications. Femoral Artery to Heart Circulation Time in Diagnosis..... 893
- OPPENHEIMER, M. J., ET AL. In Vivo Visualization of Intracardiac Structures with Gaseous Carbon Dioxide. Cardiovascular-Respiratory Effects and Associated Changes in Blood Chemistry..... 893

The Breast

- INGLEBY, HELEN, AND MOORE, LOLITA. Periodic Roentgenographic Studies of a Growing Human Mammary Cancer..... 894

Hernia

- SYCAMORE, LESLIE K. Radiologic Diagnosis of Hiatus Hernia..... 894

The Digestive System

- DAVIES, PAUL M. Some Diagnostic Difficulties in Cases with Cascade Stomach and Chronic Gastric Volvulus..... 894

- NAKAYAMA, KOMEI. Pancreaticosplenectomy Combined with Gastrectomy in Cancer of the Stomach..... 894
- HAJDU, N., ET AL. Closed Loop Obstruction of the Afferent Limb. A Late Complication of Antecolic Partial Gastrectomy..... 895
- DEAN, DAVID L., ET AL. Intussusception in Adults..... 895
- MOORE, THOMAS C. Congenital Intrinsic Duodenal Obstruction: 32 Cases..... 895
- ROSENBURG, SIDNEY A., AND SAMFSON, ARNOLD. Syndrome of Mesenteric Vascular Compression of Duodenum. 11 Cases with Operative Correction..... 896
- RABINOVITCH, JACOB, ET AL. Primary Carcinoma of the Infrapapillary Portion of the Duodenum..... 896
- BERMAN, CARROLL Z. Roentgenographic Manifestations of Congenital Megacolon (Hirschsprung's Disease) in Early Infancy..... 896
- MARSHAK, RICHARD H., ET AL. Pneumatosis Involving Left Side of Colon..... 897
- HALLIGAN, EARL J., AND BABER, JULIUS J. Clinical Significance of Air and Barium in Biliary Tract..... 897
- FERRIS, DEWARD O., AND WEBER, HARRY M. Evaluation of Routine Operative Cholangiography..... 897
- SACHS, MAURICE D., AND PARTINGTON, PHILIP F. Cholangiographic Diagnosis of Pancreatitis..... 897
- The Musculoskeletal System**
- MAUDSLEY, ROY H., AND STANSFELD, ALFRED G. Non-Osteogenic Fibroma of Bone..... 898
- KEISER, G., AND HARTMANN, H. Atypical Reticulum-Cell Sarcoma of the Skeletal System..... 898
- CARNESALE, PETER L., AND STEGMAN, KENNETH F. Blastomycosis of Bone..... 898
- LE BUS, HOWARD E. Unusual Osteochondroses..... 898
- STARK, ERNEST, ET AL. Radiologic and Pathologic Bone Changes Associated with Urticaria Pigmentosa..... 899
- ROAF, ROBERT. Paralytic Scoliosis..... 899
- JAMES, J. I. P. Paralytic Scoliosis..... 899
- BORRELLI, F. J., AND MAGLIONE, A. A. Importance of Myelography in Spinal Pathology: 150 Cases..... 900
- TUCKER, ARTHUR S. Myelography of Complete Spinal Obstruction..... 900
- PEACHER, WILLIAM G., AND STORRS, RICHARD P. Roentgen Diagnosis of Herniated Disk with Particular Reference to Diskography (Nucleography)..... 901
- SABANAS, ALVINA O., ET AL. Natural History of Osteoid Osteoma of Spine..... 901
- ROSENBERG, NORMAN, ET AL. Prognosis and Early Diagnosis of Nonunion of Femoral Neck Fractures by Laminography..... 902
- The Spinal Cord**
- PORTER, EDWARD C. Measurement of Cervical Spinal Cord in Pantopaque Myelography..... 902
- Gynecology and Obstetrics**
- WHITTLESEY, ROBERT H., ET AL. Atresia of Vagina in Infancy..... 902
- The Genitourinary System**
- BALESTRA, G., AND DELPINO, B. "Spongy" Kidney and Nephrocalcinosis..... 903
- MYHRE, JON R. Arteriovenous Fistula of Renal Vessels..... 903
- WINTER, CHESTER C. Clinical Study of New Renal Function Test: Radioactive Diodrast Renogram..... 903
- JONES, MALCOLM D., ET AL. Sodium Amido-trizoate (Hypaque) and Sodium Acetrizoate (Urokon). Comparison of Efficacy in Intravenous Urography..... 904
- HOFFMAN, HOWARD A., ET AL. Urologic Examination with the New Radiopaque Mediums, Diatrizoate, Acetrizoate, and Diprotizate..... 904
- NESBITT, TOM E., ET AL. Hypaque Sodium, a New Urographic Contrast Medium..... 904
- NICOLAI, CHARLES H. Major Reactions to Intravenous Urographic Media..... 904
- SUSSMAN, RALPH M., AND MILLER, JAY. Iodide "Mumps" After Intravenous Urography..... 905
- The Adrenals**
- HARRISON, RICHARD H., III, AND DOUBLEDAY, LEONARD C. Roentgenological Appearance of Normal Adrenal Glands..... 905
- Miscellaneous**
- CIFARELLI, FRANCISCO P. Radiological Diagnosis of Hydatidosis..... 905
- JACOBSON, GEORGE, AND ZUCHERMAN, SIDNEY D. Roentgenographically Demonstrable Splenic Deposits in Sickle Cell Anemia..... 905
- Technic**
- GERGELY, R., ET AL. Diagnostic Possibilities of Lymphangiography..... 906
- SÜSSE, H. J. Dangers and Technic of Osteomyelography and Transosseous Venography..... 906
- COLLER, J. S. A New Method of Measurement of Objects by X-rays with Special Reference to Pelvimetry..... 906
- VERBIEST, H., AND FEDDEMA, J. Cerebral Cine-Angiography with Image Intensifier..... 907
- OKAWA, CHIVEKO, AND TROMBKA, J. I. The Technic of Making Microangiograms of Rabbit Bone Marrow..... 907
- RADIOTHERAPY**
- MARCHETTA, FRANK C., AND MATTICK, WALTER L. Carcinoma of Tongue. Treatment and Results Without Radical Surgery..... 907
- WILDERMUTH, ORLISS, AND EVANS, JOHN C. Special Problem of Cancer of Eyelid..... 908
- KUTZ, EUGENE R. Influence of Histologic Type on Survival Following Radiotherapy of Bronchogenic Carcinoma..... 908

- FULLER, DENIS. Carcinoma of Oesophagus and Gastric Cardia..... 908
- RANDALL, JOHN H., AND GODDARD, WILLIAM B. A Study of 531 Cases of Endometrial Carcinoma..... 909
- MAURER, H.-J. Moving Field Therapy of Gynaecological Tumours in Pelvis..... 909
- HULTBERG, SVEN, AND ZIMMERMANN, V. BELLOCH. Radiotherapy of Xanthomatous Giant-Cell Tumors..... 909
- BAENSCH, WILLY. Rare Bony and Parosteal Tumors in Which Radiotherapy is Not Indicated..... 909
- WASSERBURGER, KARL. Treatment of Dupuytren's Contracture..... 910
- GARDINI, GIOVANNI F., AND BETTI, ROBERTO. The Radiologist Facing Evident and Latent Thymic Hypertrophy..... 910
- LANIER, RAYMOND R., ET AL. Augmenting Effects of Radiation Therapy by Chemotherapy and Other Agents..... 910
- BELLION, B. ET AL. Utilization of a 31-MEV Betatron for Radiation Therapy..... 910
- ZENDLE, B., ET AL. Dose Distributions in Water for Betatron X-Rays up to 37 Mev..... 910
- KOLB, WALTER. The Scintillation Spectrometer, a Measuring Instrument in Radiological Practice..... 911

RADIOISOTOPES

- BECK, ROBERT E., ET AL. Technical Considerations in I^{131} Tracer Studies..... 911
- DEAMICIS, EGILDA, AND WILLIAMSON, EARLE W. Determination of Radioiodine Uptake in Thyroids by Two Methods..... 911
- FRANCO, VICTOR H., AND QUINA, MARIO G. Pneumo-Thyroid: A New Procedure for Determining the Mass of the Thyroid Gland for the Radioiodine Treatment of Hyperthyroidism..... 912
- PAULSON, ELMER C. Radioiodine Uptake in Diagnosis of Thyroiditis..... 912
- ROSS, DONALD E. Cancer of Thyroid Gland..... 912
- STANBURY, JOHN B., ET AL. Metabolism of Iodotyrosines. II. Metabolism of Mono- and Di-Iodotyrosine in Certain Patients with Familial Goiter..... 912
- ENGELS, EDWARD P., ET AL. Therapy of Serous Cavity Effusion with Colloidal Radioactive Gold 198..... 913
- TRISTAN, THEODORE A., ET AL. Disseminated Histiocytosis X (Letterer-Siwe's Disease) Treated Unsuccessfully with Radioactive Colloidal Gold (Au^{198})..... 913
- BECKER, JOSEF, AND SCHEER, KURT E. Clinical Aspects of Treatment of Carcinomas of the Gastrointestinal Tract with Isotopes..... 913

- TYOR, MALCOLM P., AND ELDRIDGE, JAMES S. A Comparison of the Metabolism of Rubidium 86 and Potassium 42 Following Simultaneous Injection into Man..... 913
- DRURY, DOUGLAS R., ET AL. Rate of Elimination of Labeled Carbon Dioxide from Body... 914

RADIATION EFFECTS—PROTECTION—EXPERIMENTAL STUDIES

- SPIERS, F. W. Radioactivity in Man and His Environment..... 914
- STONE, DANIEL J., ET AL. Fatal Pulmonary Insufficiency Due to Radiation Effect upon Lung..... 915
- HENZI, HAROLD. Pathological Anatomy of Changes Involving Pulmonary Parenchyma after High Doses of X-Rays..... 915
- CARROLL, ROBERT E., ET AL. Osteogenic Sarcoma of Phalanx After Chronic Roentgen-Ray Irradiation..... 915
- DYSON, E. D. Shoe-Fitting X-Ray Fluoroscopes. 915
- CONARD, ROBERT A. Some Effects of Ionizing Radiation on the Physiology of Gastrointestinal Tract. Review..... 916
- TAYLOR, LAURISTON S. Radiation Protection for General Practitioner..... 916
- SOOLE, B. W. Photographic Badges for Estimation of Quality of X and Gamma Radiation... 916
- MACDONALD, GEORGE E., AND HOYT, LYMAN H. Corticotropin (ACTH) Gel in Treatment of Irradiation Enterocolitis. Two Cases..... 917
- NETSKY, MARTIN G., ET AL. Effect of Single Doses of Roentgen Radiation on Experimentally Induced Gliomas: with a Critical Review of Effects of Roentgen Radiation on Gliomas in Man..... 917
- ELLINGER, FRIEDRICH, ET AL. Use of Small Laboratory Animals in Medical Radiation Biology. IV. Correlation of Physical Factors with Biological Effect Produced by Total-Body Irradiation of Guinea Pigs..... 917
- BIRKNER, RUDOLPH, ET AL. Early Changes of Bone of Adult Guinea Pigs after Roentgen Irradiation..... 917
- MOLLURA, JOSEPH L., AND GOLDFEDER, ANNA. Alkaline Phosphatase Activity in Various Mouse Tissues Following Total Body X-Irradiation..... 917
- SEALANDER, JOHN A., JR. Influence of Temperature Stress on Uptake of P^{32} in Rat..... 918
- ALLAM, M. W., ET AL. Transplantability of Canine Thyroid Carcinoma Through Thirty Generations in Mixed-Breed Puppies..... 918
- STAPLETON, G. E., AND EDINGTON, C. W. Temperature Dependence of Bacterial Inactivation by X-Rays..... 918

ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Rapid Serial Angiography. Torgny Greitz. *Acta radiol.* 46: 285-298, July-August 1956. (Serafimer-lasarettet, Stockholm, Sweden)

The author presents a study of rapid serial angiography as performed in 120 patients. The technic was uniform in all cases, two films per second for the first five seconds and then one film per second for ten seconds. Four milliliters of Triurol 50 per cent (similar to Urokon) was injected. The beginning and end of the injection and the exposures were recorded on an electrocardiographic strip.

The circulation time was determined as the interval between the maximum concentration of contrast medium in the carotid siphon and in the parietal veins. A study was made of the difference in phase in contrast filling of different veins. The superficial frontal veins and the veins of the sylvian fissure are generally the first to fill and are usually the first to begin emptying. The septal vein is late in beginning to fill and also late in emptying. The superficial parietal veins seem to constitute a representative average for the cerebral veins.

Circulation times were also determined by means of radioactive isotopes and the observations compared with the times computed by rapid serial angiography. In 8 cases contrast medium and radioactive isotope were mixed and injected together. In these experiments, the peak of the arterial phase coincided in time with maximum contrast filling of the carotid siphon. The peak of the venous phase came immediately after maximum contrast filling of the transverse sinus. The maximum filling of the parietal veins as demonstrated on the roentgenogram corresponded to the peak of the isotope curve.

In another series of experiments circulation time was determined first by angiography and later by isotopes. Generally, the circulation time determined by isotopes was about 50 per cent longer. This is accounted for by the time corresponding to the passage from the parietal veins to the jugular vein.

The circulation time through arteriovenous malformations determined by angiography corresponded with that obtained from isotope experiments. The isotope curve has a characteristic appearance, rising steeply in the venous phase. When the circulation time is prolonged—for instance, in the presence of a tumor—the venous curve is flat and its peak less well marked.

While none of the author's series of patients were completely normal, there were 20 in whom epilepsy or headache were the chief complaints, and these, in the absence of demonstrable vascular changes and neurologic disturbances, were regarded as a normal control group.

There were 42 patients with tumor, of whom 23 had choked disks. In this latter group the average circulation time was approximately six seconds, a marked increase over the control group. Tumor patients without choked disks had a somewhat lower average circulation time, but still higher than the normal group. In many cases the veins draining the tumors could be identified and the circulation time through the tumor could be determined. Fifteen of the 42 tumors were vascular. In all of these, with one exception, drainage veins could be identified. Seven of the 27 non-vascular

tumors had demonstrable drainage veins, which in 5 cases were not dilated. Of the 42 tumor cases, drainage veins were thus identified in 21.

Fourteen roentgenograms; 8 diagrams.

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Cerebral Serial Angiography on 70 mm Film Size. Heinz Vieten. *Acta radiol.* 46: 315-320, July-August 1956. (Roentgen Institute of the Surgical Clinic of the Medical Academy of Düsseldorf, Düsseldorf, Germany)

A special Skull-Odelca 70-mm. camera has been developed with which it is possible to obtain serial cerebral angiograms by means of fluorography at a substantially lower cost than conventional roentgenograms. An additional advantage of the medium size of the film is that several roentgenograms can be viewed simultaneously without difficulty. Compared with small-film (35-mm.) fluorography, the medium-size film is superior in quality and also offers the advantage of being directly observable without the use of a projection screen or enlargement of the image. A magnifying lens may be used if desired.

With the Skull-Odelca it is possible to take a continuous series of sixteen to twenty lateral skull roentgenograms having the necessary density for angiography. It is therefore possible, with a picture frequency of 2 per second, to cover a total time of eight to ten seconds, which is usually sufficient for serial angiograms of the brain. The camera has not been found to be useful for obtaining serial roentgenograms in the sagittal projection. Approximately twice as much radiation must be used as for direct large-size roentgenograms.

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Cerebral Angiographic Studies Following Surgical Treatment of Intracranial Aneurysms. Angiographic Evaluation of Results. Lester A. Mount and Juan M. Taveras. *Acta radiol.* 46: 333-341, July-August 1956. (Department of Neurological Surgery and Radiology, Columbia University College of Physicians and Surgeons, New York, N. Y.)

In order to study the response of intracranial aneurysms to surgical treatment, cerebral angiography was performed from several weeks or months to a few years following the initial operation. Forty-two patients were studied, 32 of whom had aneurysms of the internal carotid artery, 7 middle cerebral aneurysms, 8 anterior communicating artery aneurysms, and 1 a pericallosal artery aneurysm. Six patients had two aneurysms.

The surgical procedure consisted of ligation of the internal carotid artery in the neck in 27 patients, ligation of the common carotid artery in 3, intracranial artery ligation or clipping of the aneurysm in addition to ligation in the neck in 4. In 8, the procedure was limited to intracranial clipping of the aneurysm or of the feeding vessel. In 3 patients the internal carotid artery was clamped, and the common carotid was ligated later, when the clamp was found to be open.

It was found that in some of the cases the arterial lumen was not actually occluded at the site of the attempted ligation. It is possible that recanalization occurred or that some atrophy of the arterial wall had developed subsequent to the application of the clamp. In some cases the clamp might not have been completely

closed. In 16 cases complete permanent ligation was accomplished. In 7 of these 16 cases the aneurysmal sac was not demonstrable subsequent to surgery; in 3 the sac had become considerably smaller, and in 2 it remained unchanged in size. In no case had it become larger. The aneurysmal sac was no longer demonstrable in 11 of 30 patients in whom either permanent or temporary ligation of the internal carotid artery was accomplished, but the proportion of presumably thrombosed aneurysms was higher (7 out of 12) in the patients in whom the internal carotid artery was shown to be completely occluded. All of the presumably thrombosed aneurysms were in the internal carotid artery. In the 6 cases of middle cerebral artery aneurysm, the sac was demonstrated in repeat angiography, although it was considerably smaller in 3 of the cases.

Intracranial approach to the aneurysm with clipping of the aneurysmal sac or of the feeding vessels was successful in all but 1 case, and is considered to be the treatment of choice.

Eleven roentgenograms; 1 table

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Another Method of Vertebral Angiography. E. Lindgren. *Acta radiol.* 46: 257-261, July-August 1956. (Serafimerlasarettet, Stockholm, Sweden)

A method for performing vertebral angiography in those cases in which percutaneous puncture is not possible is described. The author has encountered difficulties with the percutaneous method in about 10 per cent of the patients examined.

The femoral artery is punctured percutaneously with a comparatively thick cannula, through which a polyethylene catheter is inserted into the aorta to the level of the aortic arch. The left femoral artery is usually punctured, because on this side the iliac artery often has a straighter course than on the right side, and because it appears that the catheter passes more readily into the subclavian artery from the left. When the position is adjudged to be correct, a test injection is made and, if necessary, the position of the catheter is adjusted. Injections may be made with the tip of the catheter in the aorta near the origin of the subclavian artery or within the lumen of the subclavian artery. If the injection is made into the aorta, a larger amount of contrast medium is necessary. Generally, with the catheter in the subclavian, 15 ml. is employed. The examination is always performed under general anesthesia.

This method was used in 10 cases and satisfactory roentgenograms were obtained in all of them.

Six roentgenograms. HOWARD L. STEINBACH, M.D.
University of California, S. F.

Atrophy Within the Brain Stem Area Following Injection of Thorotrast into the Vertebral Artery. A Report of a Case. Tormod Hauge. *Acta radiol.* 46: 342-345, July-August 1956. (Department of Neurosurgery, University Hospital, Oslo, Norway)

A case is reported in which the injection of Thorotrast into the vertebral artery was followed by serious complications. The patient suffered from bulbar symptoms considered to be due to a vascular lesion in the brain-stem area. Six milliliters of Thorotrast was injected into the right vertebral artery. Three minutes later the bulbar state became markedly accentuated and the patient lost consciousness. The pupils reacted to light

but the corneal reflexes were diminished. There was no response to painful stimuli; hypotonic quadriplegia was present, and all deep reflexes were absent. In spite of the patient being unconscious, the electroencephalogram was normal. An arteriogram showed the opaque material extending to the superior cerebellar arteries, but no filling of the posterior cerebral arteries could be demonstrated.

The patient died a year and a half later from a coronary thrombosis, at which time an autopsy was performed. An aneurysm was demonstrated in the superior portion of the basilar artery, obstructing the posterior cerebral arteries. Sections of the medulla oblongata revealed bilateral atrophy of the pyramidal tracts, the posterior fasciculus, the median lemnisci, and the cerebellar tracts. The whole pontine region was almost completely destroyed, and there was atrophy of the posterior part of the mesencephalon, including the inferior colliculus. The cerebellum showed almost complete degeneration.

The author concludes that at the present time there is no contrast medium which is wholly innocuous to the vascular wall.

One roentgenogram; 3 photographs.

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Contribution to the Methods of Filling the Posterior Fossa and the Adjoining Cervical Subarachnoid Space with Small Quantities of Air. H. Verbiest. *Brit. J. Radiol.* 29: 440-444, August 1956. (Neurosurgical Department, University Clinic, Utrecht, Holland)

A method of cisternal fractional encephalography of the posterior fossa fluid spaces is described. The patient is placed in a prone position, with the head anteflexed, on a tilting table. Air is introduced by cisternal puncture and, with the needle remaining in place, the table is inclined about 45°. Air enters the cisterna magna and the space around the posterior and superior part of the cerebellum. Air may also pass into the cisterna venae magnae, cisterna ambiens, and the posterior part of the convexity. Further inclination of the table may result in filling of the fourth ventricle. A slight Trendelenburg position is sufficient for cisternography. The cisternal needle is then withdrawn, the patient is turned on his back and raised to 45° until a frontal headache occurs, when he is rapidly placed in the horizontal position with the head slightly retroflexed. The passage of air to the convexity may then be studied by anteflexion of the head.

A modification of this procedure may be used. With the patient prone, 30 c.c. of air is injected via the cisternal route. The air passes into the spinal subarachnoid space. After removal of the needle, the air is moved into the posterior fossa by progressive inclination of the tilt table. With 30° the air fills the dorsal part of the cervical subarachnoid space. Further inclination to 45° makes the air pass into the cisterna magna and possibly over the posterior and superior portion of the cerebellum. An additional inclination of about 15° may result in filling the anterior part of the cisterna magna and the fourth ventricle.

A spirit level is used to indicate on the films the position of the head in relation to gravity.

Five roentgenograms; 2 photographs.

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Roentgenographic Signs of Tumors of the Brain.

Eva L. Gilbertson and C. Allen Good. *Am. J. Roentgenol.* 76: 226-247, August 1956. (E. L. G., 706 Summit Ave., Seattle, Wash.)

The authors report a study undertaken to determine the value of plain films of the skull in diagnosis and localization of tumors of the brain. The series contains 661 proved cases of brain tumor seen over a five-year period at the Mayo Clinic. Localizing signs and general signs of increased intracranial pressure are discussed for each of the major tumor types. The former are (1) calcification within the lesion; (2) pineal and/or choroid shift; (3) hyperostosis and osteomatous formation; (4) erosion or destruction of bone; (5) erosion of the sella turcica (in intrasellar tumor); (6) increased vascularity. The latter are (1) sellar erosion; (2) separation of sutures; (3) hydrocephalus; (4) convolitional atrophy; (5) increased vascularity. The incidence of each sign is given for the various neoplasms. The treatise presents a wealth of information and is strongly recommended in its original form for those interested in this subject. The following abstract of pertinent information consists largely of the authors' own summary, with a few modifications and additions.

Some indication of an intracranial lesion was present in about two-thirds of the plain skull films reviewed. Pituitary gland tumors showed the highest incidence of localizing signs (95 per cent).

Gliomas constituted slightly less than half of all the tumors and 53 per cent of these showed positive roentgen findings. Calcification within the neoplasm was the most important localizing sign and in some instances suggested the histology. Strand-like calcific deposits occurring in a patient over forty years of age suggest oligodendroglioma, particularly when associated with some erosion of the inner table of the skull in the region of the tumor. Similar strand-like calcification in a patient under forty years of age indicated astrocytoma. Small punctate areas of calcification were encountered in ependymomas and spongioblastomas. The former were usually seen in patients less than thirty years of age, while the spongioblastomas occurred in older persons. Calcification in gliomas tends to be deeply situated within the cerebral hemisphere in contradistinction to the more superficial calcification associated with meningiomas.

A high percentage of meningiomas can be localized and recognized as to type by the occurrence of hyperostosis or other bone reaction adjacent to the tumor. Meningiomas not infrequently showed punctate calcification in discrete masses, but this was likely to be obscured by the bone reaction. When punctate calcification was unassociated with bone reaction, it tended to be localized in those areas where meningiomas are most common, i.e., parasagittal or basofrontal regions or immediately under the meninges of the cerebral hemispheres. Almost all meningiomas occurred in patients over forty-five years of age.

Craniopharyngiomas frequently showed punctate or flocculent calcification but the site of the calcium and the early age of the patient usually indicated the diagnosis.

Increased digital markings and increased skull vascularity are occasionally associated with brain tumors but are not considered important unless accompanied by other signs of tumor. These two signs vary in normal individuals and can be misleading. Signs of general increase in intracranial pressure such as secondary

erosion of the sella and separation of sutures have no localizing value. Displacement of the pineal may allow a general impression of tumor site.

Seventeen roentgenograms; 1 table

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Generalized Cysticercosis with Cerebral Infestation.

Trevor Owen and Michael Lenczner. *Canad. M. A. J.* 75: 213-216, Aug. 1, 1956. (Toronto General Hospital, Toronto, Canada)

Systemic infestation by the larvae of *Taenia solium* is rare in man, at least in regions where a measure of personal hygiene is observed. Following ingestion of the eggs, the embryos are liberated by the action of gastric juice, invade the blood stream, and settle in all body tissues to form cysts. Eventually the worms in the cysts die, stimulating considerable reaction on the part of the host, which terminates in calcification. Symptoms are produced by local pressure, depending on the location. Neurological signs are usually the most prominent. The diagnosis may be made by x-ray examination of the thighs, which are a selective site of the characteristic linear calcific densities, varying from a few millimeters to 2 cm. in length.

Two cases are presented and illustrated. One patient had both neurological changes (epilepsy) and myocardial damage; the other had headaches, petit mal attacks, and a personality pattern disturbance. Both were immigrants from areas of primitive hygiene.

Four roentgenograms; 1 electrocardiogram; 1 electroencephalogram. ZAC F. ENDRESS, M.D.
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Spontaneous Occlusion of the Middle Cerebral Artery. Emanuel H. Feiring and Bernard J. Sussman. *Neurology* 6: 529-546, August 1956. (Mount Sinai Hospital, New York, N. Y.)

Nine cases of occlusion of the middle cerebral artery are reported and the information derived from analysis of this material is discussed. The diagnosis was established in all instances on the basis of angiographic findings; in only 1 instance was the lesion verified anatomically.

The angiographic feature common to all but 1 case was failure to demonstrate the trunk of the artery and its major branches during the initial phase following an injection of Diodrast; a few branches of the sylvian group were seen during this phase of the study in 1 case and in a later phase in an additional 2 cases. In all 3 of these latter cases, the middle cerebral artery presumably was only partially occluded. In 2 cases, blood vessels in the distribution of the artery were visualized in roentgenograms representing a later phase of the study; this is probably the result of retrograde flow through anastomatic channels and is regarded as additional evidence of a collateral blood supply thought to follow thrombosis of this artery. In 5 cases in which anteroposterior as well as lateral views were available, occlusion of the middle cerebral artery was observed to occur at or slightly beyond the point of origin from the internal carotid artery.

A moderate degree of improvement took place in 2 cases observed for a relatively short time; very little if any change was manifest in 4 patients followed for a period of two years or longer. Death occurred in 3 instances.

Although the authors do not recommend angiography as a routine diagnostic procedure, they consider the information supplied by the present study to be of significance.

Twenty-four illustrations, including 16 roentgenograms.

Roentgenographic Findings in Trigeminal Neuralgia.

W. James Gardner, Edwin M. Todd, and J. Portugal Pinto. *Am. J. Roentgenol.* 76: 346-350, August 1956. (W. J. G., 2020 E. 93rd St., Cleveland 6, Ohio)

It has been suggested that trigeminal neuralgia is due to pressure on the sensory root of the fifth cranial nerve where it crosses the apex of the petrous pyramid of the temporal bone (Taarnhoj: *J. Neurosurg.* 9: 288, 1952). Gardner and Pinto previously suggested that compression may occur as a result of upward displacement of the petrous apex secondary to basilar impression (Cleveland Chin. Quart. 20: 364, 1953). They have now studied 130 consecutive cases of unilateral or bilateral trigeminal neuralgia, using special roentgenograms of the skull to determine elevation of the petrous pyramids. Postero-anterior views were made so as to project the petrous pyramids through the orbits; a line was drawn through the roofs of the orbits, and from this line the height of each petrous bone at the point where the sensory root crosses it was measured. Lateral views of the skull were also made, and the relationship of the tip of the odontoid process to McGregor's line (from the posterior end of the hard palate to the lowest portion of the occipital bone) was determined. A control series of 200 patients who did not have trigeminal neuralgia was obtained for both measurements.

In the control group, the right petrous pyramid was found to be higher than the left in 47.5 per cent of the examinations; the left petrous pyramid was higher in 29 per cent, and the pyramids were equal in height in 23.5 per cent. In the group with trigeminal neuralgia, the right petrous pyramid was higher in 46 per cent, the left in 34 per cent, and the pyramids were equal in 20 per cent. The average level of the superior margin of the odontoid process was 2.3 mm. above McGregor's line in the control group, with 23 per cent 5 mm. or more above the line; in the trigeminal neuralgia series, the average was 3.99 mm., with 43.1 per cent 5 mm. or more above the line.

A further analysis of the cases studied showed that the side of the neuralgia corresponded to the side of the elevated pyramid in 60 per cent and to the side of the lower pyramid in 20 per cent.

It is concluded that these findings correlate with the predominance of right-sided trigeminal neuralgia and that the basilar impression resulting in elevation of the petrous pyramid is secondary to postmenopausal osteoporosis, explaining the more common occurrence in elderly women.

Four roentgenograms; 5 tables.

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Radiological Anatomy of the Temporal Bone.

Máximo García Castañeda, Isaías Balanzario, Benjamín Macías, Carlos Martínez Fabre, and Moisés Zarkin T. *Radiologia* 6: 101-109, June 1956. (In Spanish) (Mexico, D. F.)

The authors review the roentgenologic anatomy of the temporal bone on the basis of their experience with plain films and present a new classification of the cellular

system with some change in terminology. The principal anatomical features of the bone as seen in the Schüller, Stenvers, Mayer, and Law views are described and the following conclusions are emphasized.

The Schüller postero-anterior view is useful in visualizing the medial portion of the petrous pyramid and in the diagnosis of tumors and fractures of the petrosquamous angle. The mentovertex view permits determination of the dimensions of the petrous pyramid and visualization of the tympanic cavity, head of the malleus, and the eustachian tube. In the antero-posterior Plagemann view, evaluation of mastoid cells and styloid processes may be made. The Chamberlain-Towne view is valuable for the styloid process, the mastoids, and axial visualization of the petrous pyramid. The petrous pyramid is also visualized by means of the Stenvers view, which gives information on the labyrinth the internal acoustic meatus, and facial canal. The internal and external acoustic meati, the tympanic cavity, the carotid canal, as well as fractures or change in volume of the petrous pyramid, are well delineated by Mayer's view.

Five drawings.

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Grooved Atrophy of the Parietal Bone. J. Gros. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 85: 154-158, August 1956. (In German) (Medizinische Klinik der Stadt. Krankenanstalten Wiesbaden, Wiesbaden, Germany)

Although grooved atrophy has no particular significance as a disease, it is of interest as an uncommon skull finding. Parietal bone thinning has been so marked in some instances that brain pulsations could be visualized through the scalp. The process tends to occur in elderly persons and may be related to senile osteoporosis though it has occasionally been reported in the young. The cause is unknown. Various explanations have been suggested: a trophic change associated with cerebral disease, pressure atrophy from the movements of the galea aponeurotica, and, as suggested above, a variation of senile osteoporosis.

The literature on the subject deals with the entity as "parietal thinning." Camp and Nash reported 119 cases (*Radiology* 42: 42, 1944) and Epstein 26 (*Radiology* 60: 29, 1953). Two types of change have been distinguished: one a uniform thinning and the other a deep grooving of the parietal bone. All 5 of the author's patients were elderly individuals. One female gave a history of weight carrying on the head. In the other four cases there was no clue as to possible etiology.

Seven roentgenograms; 1 photograph.

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Roentgen Signs of Space-Occupying Lesions of the Orbit. L. Psenner. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 85: 125-141, August 1956. (In German) (Zentral-Röntgeninstitut der Universität Wien, Vienna, Austria)

In radiographing the orbit, contrast studies such as the orbitography of Thiel have found little favor. The Caldwell, the Rhese, and the lateral views are the projections of choice.

The intraorbital extraocular soft-tissue processes which produce roentgen changes include orbital phlegmon due to foreign body, inflammatory pseudotumor of the orbit, benign orbital neoplasm, malignant

neoplasm, tumor of the optic canal, and tumor of the lacrimal gland. Inflammatory pseudotumor of the orbit is a specific entity characterized pathologically by severe lymphocytic infiltration of the retro-ocular tissues. It may be related to Mikulicz' disease. The roentgenogram is either negative or shows a diffuse enlargement of the entire bony orbit. Biopsy is necessary to establish the diagnosis and roentgen therapy is the treatment of choice. Hemangioma and optic neuroma are the only two benign tumors with x-ray signs of a characteristic nature. Hemangioma exhibits small round areas of calcification corresponding to thrombi within the tumor. There may be associated pressure defects in the orbital wall. Tumors of the optic canal, such as optic neuroma, are demonstrated by enlargement of one optic foramen in the Rhese projection. Malignant tumors of the orbit, as sarcoma and metastatic neoplasms, produce no roentgen signs if they involve soft tissues only. Lacrimal gland tumors, usually cylindromas, cause a localized thinning of the orbit with an associated smooth, sharply contoured defect in the upper outer aspect of the supraorbital ridge.

Disease of the bony orbit is represented by the osteoma, the bone hemangioma, the epidermoid tumor, and the eosinophilic granuloma. Malignant tumors of the bony orbit are metastatic neoplasms, bone sarcoma, and carcinoma. The benign osteoma almost invariably arises in a sinus and involves the orbit secondarily. The osteo-angioma arises in the bone, is usually benign, and shows characteristic although not pathognomonic radiating spicules. Epidermoids and granulomas are revealed by localized radiolucencies with sharp borders. The malignant tumors are all represented by bone destruction.

Many processes arising outside the orbit involve this region secondarily. Sinusitis with osteomyelitis is now becoming rare but may be anticipated in the frontal region. Mucocoele and its infected variety, the pyocoele, most frequently originate in the frontal sinuses and may produce massive atrophy in the region of the orbit. Both fibroma and fibrosarcoma may arise in a paranasal sinus and secondarily extend to the orbit. The same is true of sarcoma. All three conditions are quite rare. Of the intracranial lesions which extend forward, the most important is the meningioma of the middle cranial fossa. Bone production and bone condensation commonly occur in association with meningioma and may be quite distinctive on the film. Involvement in the region of the sphenoid fissure, either with bone condensation or bone necrosis, may be noted.

Thirty roentgenograms.

WILLIAM F. WANGNER, M.D.
Royal Oak, Mich.

Congenital Defect of the Bony Orbit and Pulsating Exophthalmos. Hooshang Tayebi and Frederic N. Silverman. *J. Dis. Child.* 92: 138-146, August 1956. (University of Cincinnati College of Medicine, Cincinnati, Ohio)

Two cases of congenital defect of the orbit in young children are reported and a general review of the anomaly is presented. Associated with the defect there is likely to be cerebral herniation (encephalocele) into the anterior or posterior bony orbit. Anteriorly the defect is located between the frontal bone, lacrimal bone, cribriform plate, and nasal process of the maxilla, with the herniation sometimes visible at the base of the nose. In the posterior type the orifice may be an

anatomic opening, normal or enlarged in size, such as the posterior ethmoid foramen, optic foramen, or, as in one of the authors' cases, the superior orbital fissure.

Associated congenital abnormalities of the skull and eyes may be present. The authors' first patient showed bony dehiscences at the ipsilateral antero- and posterolateral fontanelles, involving the frontal, temporal, parietal, and occipital bones. Exploration revealed enlargement of the temporal lobe with diminution of the frontal lobe. Cerebral angiography merely showed forward displacement of the carotid siphon.

Many cases of partial absence of the orbital wall accompany neurofibromatosis, and clinical manifestations of the latter condition should be specifically sought. In the first case reported here the child reached the age of eleven and underwent a third exploratory operation before a large subcutaneous neurofibroma was excised.

The radiologic features of bony orbital defect are strongly suggestive and, if properly interpreted, may permit delay of biopsy until definitive surgical plans can be carried out. The x-ray findings vary both with the degree of involvement and with the patient's age, increasing with time. In the posterior variety, exemplified by the authors' cases, there is absence of the apex of the orbit and of varying portions of the roof and wall, leading to overall enlargement, with absence of the landmarks usually demonstrable in the frontal projection. It may become impossible to identify the lesser sphenoid wing; if the greater wing is involved, the orbital fissures enlarge and coalesce, and eventually the bottom seems to have fallen out of the orbit, leaving a clear view through it. With a large defect and cerebral herniation, the sphenoidal ridge may be compromised, leading to its apparent anterior displacement at the expense of the anterior fossa, with an actual and relative enlargement of the middle fossa.

A diagnostic feature of the cerebral herniation is the pneumoencephalographic demonstration of subarachnoid air extending into the orbit but still conforming to the shape of the invisible dura. This feature is best shown by a lateral horizontal beam examination in the "brow-up" position.

In the differential diagnosis arteriovenous fistula may be suspected because of the pulsating exophthalmos, but a bony defect in the orbit is usually absent. Xanthomatosis may lead to non-pulsating orbital defects which, like the congenital variety, involve both cartilaginous and membranous bone. The presence of chronic otitis, diabetes insipidus, and the involvement of other bones in xanthomatosis allows for differentiation. Dermoids and epidermoids involving the orbit tend to widen the diploe, the defect being ringed with a sclerotic margin. Surgical defects of the orbit are usually prevented from producing pulsating exophthalmos by scar formation. In the presence of chronic hydrocephalus and after trauma, a communication between the intracranial and orbital cavities may ensue. These should present no real diagnostic difficulties.

Five roentgenograms; 3 photographs.

SAUL SCHEFF, M.D.
Boston, Mass.

Retrolbulbar Air Injection with Planigraphy. G. Richard Keskey and William R. Letsch. *Arch. Ophth.* 56: 248-256, August 1956. (Edward Mallinckrodt Institute of Radiology, St. Louis 10, Mo.)

Retrolbulbar injection of air with planigraphy de-

lineates some space-occupying lesions not demonstrable by routine roentgenography. The procedure has been used in 26 patients, without evidence of damage to orbital structures. Air was completely absorbed in seventy-two to ninety-six hours, with restoration of full preinjection mobility of the globe. Neither visual fields nor visual acuity was altered. Diffusion proved satisfactory, with air visualized in all aspects of the orbit when properly injected. Although air provides less contrast with the orbital structures than does a radiopaque contrast medium, this disadvantage is outweighed by the safety and diffusibility of air.

Eight of the 25 air injections were performed on normal orbits for purposes of developing the technic and establishing the appearance of the normal air-filled orbit. Seventeen were done on patients with exophthalmos. In 3 of these, with a presumptive diagnosis of thyrotoxic disease, air injection provided no additional information. One patient was examined twice. In 6 of the remaining 13 cases, retrobulbar air injection with planigraphy revealed space-occupying lesions which could not be localized by routine x-ray studies. All 6 were proved by surgical exploration and biopsy. In only 1 of these, the first examination carried out by the authors, was the location of the tumor misinterpreted. In retrospect, the localization was obvious.

Postero-anterior planigrams following air injection in a normal orbit demonstrated the globe, in anterior sections, as a regularly rounded dense image approximately 2 cm. in diameter. Sections posterior to the globe showed the optic nerve occupying the approximate center of the orbit, appearing as a stellar image roughly 1 cm. in diameter. The loose connective tissue surrounding the optic nerve probably accounts for its large size. Extending outward from the optic nerve, the four obliquely directed extensions of the extraocular muscles are visualized in hazy outline.

Lateral sections of the normal orbit revealed the outline of a major portion of the globe, the juxtabulbar portion of the optic nerve, and, in many cases, the superior and inferior extraocular muscles. Lateral sections near the mid-line are difficult to interpret because of confusing air shadows in the ethmoid sinuses. In general the postero-anterior sections proved more informative than the lateral.

In abnormal orbits the observations depended upon displacement or compression of the globe, optic nerve, or muscles, associated with an intraorbital mass. In some instances the picture was simply one of enlargement of a normal structure without recognizable displacement. Planigraphy after air injection indicated in some patients the advisability of a comparatively simple inferior surgical approach, thus avoiding unnecessary and more complicated superior or temporal exploration.

Bilateral air injections have recently been employed, permitting direct comparison of the normal and the involved orbit.

The absence of air in part of the orbit does not necessarily mean the presence of a space-occupying lesion. It was not always possible to distribute air uniformly about the orbit, and diagnosis cannot be established solely on the basis of incomplete filling. This served to emphasize the fact that interpretation of the orbital planigrams requires the close collaboration of the radiologist, ophthalmologist, and the neurosurgeon, with due consideration given to the clinical findings.

Fourteen roentgenograms, with 15 accompanying line drawings.

Headache from Subluxations of the Cervical Articulations. Ákos Kovács. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 85: 142-153, August 1956. (In German) (Röntgenabteilung des Rokus-Krankenhauses, Budapest, Hungary)

Various conditions, as a constitutional weakness of the connective tissue of the cervical spine, a relaxation of the ligaments, or a premature breakdown of the joint cartilage, may lead to subluxation of the upper cervical zygapophyseal joints. The excessive shift of one articular facet on the other in certain instances disturbs the alignment of the transverse foramen and thus produces pressure upon the vertebral artery. This pressure, either by directly reducing the blood flow in the artery or by reflex action through the associated sympathetic plexus, produces headache, which is likely to be one-sided, tending to originate in the back of the neck and radiate to the parietal region, perhaps as far as the forehead. It occurs in persons from the age of fourteen to forty with no gross history of injury. Physical examination may be negative or may demonstrate discomfort, with production of the headache on hyperextension of the neck.

While radiography may be done by conventional technics, with lateral projections in both neutral and hyperextension positions, the author prefers two tomograms, one taken 1.5 cm. to the right and the other 1.5 cm. to the left of the mid-line. These tomograms project the lateral processes without confusing superimposition from the two sides. The transverse foramina for the vertebral artery are usually well shown.

Not all subluxated facets as demonstrated radiographically cause headache, since the vertebral artery may lie medial to the facet. In favorable instances osteophytes may limit the shift and prevent pressure on the artery. Subluxation may be primary, as in the cases discussed in this article. It may also be secondary to disk degeneration, spondylarthrosis, and degenerative disease of the articular processes, all of which may produce pressure on the vertebral artery. In older persons atherosclerosis is a predisposing factor, because of the rigid tortuosity of the vessel.

Roentgenographically subluxation may be indicated by a horizontal shift of an articular facet, usually of the upper dorsal to the lower. Axial shifts with obvious pinching of the joint posteriorly, and thus with relative widening anteriorly, also occur. In older individuals one may see an enlarged joint by reason of osteophyte formation plus a shift in position.

Certain individuals seem constitutionally predisposed to this ailment, and are prone to experience symptoms when indulging in certain athletic exercises or on sitting for prolonged periods with the head bent backward, as in the cinema. In the 6 cases reported by the author as typical, the history and radiographic findings are convincing.

Fourteen roentgenograms; 9 drawings.

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THE CHEST

Bronchography with New Contrast Media. A Review. Sheldon E. Domm, David H. Waterman, William K. Rogers, and Christopher Cummins. *Am. Rev. Tuberc.* 74: 188-195, August 1956. (S. E. D., 1918 W. Clinch Ave., Knoxville 16, Tenn.)

The use of iodized oil in bronchography was described

more than thirty years ago and this material is still widely used. Two other media have been introduced in recent years and have advantages in certain patients. The first, iodized oil thickened with sulfanilamide, reduces the amount of alveolar filling and retention but does not prevent it. The second, oily Dionosil, overcomes the disadvantage of alveolar filling, since it is rapidly eliminated even though it may reach the alveoli. Furthermore there is less tendency for this material to extend into the alveoli since it flows more slowly than iodized oil. It does not break down to form free iodine.

The authors indicate that they prefer the Dionosil Oily as a routine bronchographic agent, but in certain instances iodized oil is useful for outlining segments which are difficult to fill with any other medium. Bronchography is an art, and the individual bronchographer should use the technic and opaque medium which give the best results in his hands. Anesthesia is a difficult problem. Cocaine is a satisfactory local anesthetic agent but must be prepared fresh before each examination. Pontocaine is toxic, and the total dose must be kept at or below 20 mg. The writers feel that 5 per cent hexylcaine hydrochloride may eventually supplant the other drugs, since it is apparently safer than Pontocaine and more stable than cocaine. Furthermore, it is not subject to narcotic regulations.

JOHN H. JUHL, M.D.
University of Wisconsin

Evaluation of 3,5-Diiodo-4-Pyridone N-Acetic Acid (Dionosil) as a Bronchographic Agent. H. G. Boren and D. V. Miller. *Am. Rev. Tuberc.* 74: 178-187, August 1956. (Baylor University College of Medicine, Houston, Texas)

On the basis of 51 bronchograms obtained in 31 patients the authors conclude that oily Dionosil is a safe bronchographic medium and can be used in patients with stabilized tuberculosis as well as in those with non-tuberculous disease. They found the oily Dionosil to be more satisfactory than the aqueous preparation and the percentage of satisfactory visualization in bronchography with oily Dionosil was comparable to that obtained when iodized oil was used. Dionosil also has the advantage of rapid clearing, so that persistent opacity in the area examined is not a factor in following the disease process. No complications were observed which could be attributed to the Dionosil and it was felt that the oily material was actually less irritating than iodized oil. The authors also believe that the density of the medium is satisfactory and the viscosity is such that films can be taken in any position in an unharmed manner.

Fourteen roentgenograms. JOHN H. JUHL, M.D.
University of Wisconsin

Postprimary Intrathoracic Tuberculosis in Childhood, with Special Reference to Its Sequelae. R. J. Derham. *Texas State J. Med.* 52: 583-588, August 1956. (Alder Hey Children's Hospital, Liverpool, England)

This study of postprimary intrathoracic tuberculosis is based upon 305 children hospitalized in Liverpool, England, for primary disease between 1948 and 1953. In 257 of this group there was evidence of either hilar or mediastinal lymph node enlargement; 31 had pleural effusions. Radiologic evidence of segmental lesions (consolidation, collapse, or obstructive emphysema) was obtained in 68.

Major sequelae developed in 35 (11.4 per cent) of the series. In 14 cases segmental collapse was followed by bronchiectasis. In 7 children tuberculous bronchopneumonia developed, with recovery in all. Eleven had miliary tuberculosis and/or tuberculous meningitis, with 5 deaths. Two cases of tuberculous pericarditis occurred, with 1 death. Other sequelae included 6 instances of cervical adenitis, 5 of bone or joint infection, 2 of tuberculous peritonitis, and 1 each of epididymitis, purpura, renal calculus, and involvement of the fallopian tubes.

The author was unable to determine the effectiveness of prophylactic drugs in preventing sequelae of tuberculosis but he concludes that chemotherapy, though not indicated routinely, should be used when a lesion appears to be exudative or progressing. It is interesting to note that in 12 per cent of the series (37 patients) erythema nodosum was the initial complaint.

Seven tables. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Primary Pulmonary Carcinoma Associated with Active Pulmonary Tuberculosis. F. Bender. *Dis. of Chest* 30: 207-216, August 1956. (Hamilton, Ontario)

The author gives 15 short case histories of co-existing pulmonary carcinoma and active pulmonary tuberculosis. The two lesions may closely resemble each other roentgenologically, and the development of carcinoma in the presence of known active tuberculosis may be overlooked. Circumscribed dense, solid lesions, atelectasis, or infiltrating hilar lesions should be viewed with suspicion.

This series included 13 males and 2 females, with an age range from thirty-five to seventy-one. The highest incidence was in the fifth and sixth decades. Six patients were heavy smokers, 2 light smokers, and 1 a non-smoker. A localized wheeze was present in 9; this is considered to occur most frequently when the main bronchus is involved. Dyspnea occurred in 11. Hemoptysis was a fairly common symptom. Sputum examination was positive for malignant cells in 4 to 7 cases. Bronchoscopic examinations were done in 12 patients and were positive in 8. Bronchial secretions were examined in 10, and malignant cells were found in 5. In 8 the tuberculosis was unilateral, and in 5 of these the carcinoma developed on the same side.

The etiologic relationship is controversial. Some believe tuberculosis plays no significant role in the production of cancer. Others claim that, while the coexistence of the two conditions is coincidental, healed foci are susceptible to neoplastic development.

Features which led to the suspicion of carcinoma in the present series were (1) atypical x-ray appearance not entirely characteristic of tuberculosis; (2) failure of improvement, clinically or radiographically, on chemotherapy; (3) clinical and roentgenologic deterioration on chemotherapy; (4) the appearance of hilar lesions while simultaneous clearing occurred in the other areas of the lungs.

Four roentgenograms. HENRY K. TAYLOR, M.D.
New York, N. Y.

Bronchogenic Carcinoma and Pulmonary Tuberculosis. Problems in Diagnosis with Special Reference to Antituberculous Chemotherapy. Herman Weissman. *Am. Rev. Tuberc.* 73: 853-867, June 1956. (Medical Service, VA Hospital, Castle Point, N. Y.)

Delay in the diagnosis of pulmonary carcinoma is

sometimes caused by improvement or disappearance of an associated infection when antimicrobial drugs are administered. This is true in patients with pulmonary tuberculosis and bronchogenic carcinoma as well as in those with nonspecific inflammatory disease associated with tumor. The author reviewed a group of 25 cases of bronchogenic carcinoma, 14 of which were associated with pulmonary tuberculosis. The tuberculous disease cleared in 9 patients on antituberculous treatment and there was questionable clearing in another. Three patients had inactive tuberculosis. In 4 instances an erroneous diagnosis of pulmonary tuberculosis was made on the basis of symptomatology plus roentgenographic findings. In 5 cases the carcinoma was not associated with other pulmonary disease.

The author stresses the importance of relating the clinical course and roentgenographic findings and points out the fallacy of relying on a single finding such as a negative cytological examination of the sputum or negative bronchoscopy. In the older age group, particularly in males, a high index of suspicion in regard to pulmonary neoplasm is necessary; it must be remembered that the presence of tuberculosis does not exclude the possibility of coexisting carcinoma.

Six roentgenograms.

JOHN H. JUHL, M.D.
University of Wisconsin

Scleroderma (Progressive Systemic Sclerosis) Associated with Cancer of the Lung. Brief Review and Report of Case. Sigmundur M. Jonsson and Joseph M. Houser. *New England J. Med.* 255: 413-416, Aug. 30, 1956. (Westfield State Sanatorium, Westfield, Mass.)

Zatuchni *et al.* reported 3 cases of lung cancer in scleroderma (*Cancer* 6: 1147, 1953. *Abst. in Radiology* 63: 592, 1954), and attention has been called to the high incidence of malignant lesions in association with the related collagen disorder, dermatomyositis.

The authors present a detailed case report of a young woman with a history of clinical progressive systemic sclerosis beginning at the age of twenty-one. She had classical scleroderma of the esophagus, pulmonary fibrosis, and atrophy and resorption of the peripheral bones of the hands and wrists, with soft-tissue calcification at the latter site.

At the age of thirty-two, a right hilar mass became apparent, followed by increasing weakness and dyspnea, with death at thirty-three, in respiratory failure. Necropsy revealed a primary right lower lobe tumor, which proved to be undifferentiated bronchogenic adenocarcinoma with areas of squamous metaplasia. There were pulmonary, hepatic, adrenal, and vertebral body metastases, as well as spread to the para-aortic, hilar, and mesenteric nodes. Elsewhere in the lungs there was diffuse fibrosis characteristic of progressive sclerosis. The esophagus, stomach, and voluntary muscles were also involved.

Although there is no uniformity as to type, tumor appears to be more common in collagenous diseases. Its possibility should be considered in this group of patients.

Three roentgenograms; 3 photomicrographs; 1 photograph.

SAUL SCHEFF, M.D.
Boston, Mass.

Evaluation of the Different Radiologic Methods in the Diagnosis of Carcinoma of the Lung. Laura Fariñas, Rafael Gómez Zaldívar, Juan Llambe, and L. Martínez Fariñas. *art. Acad. interam.* 5: 54-64, October-

December 1955. (In Spanish) (Calle 23, No. 411, Vedado, Havana, Cuba)

Various radiographic procedures for the diagnosis of malignant processes of the lung are evaluated on the basis of 133 cases of early or moderately advanced disease. In addition to the routine views of the chest, bronchography offers a high percentage of exact diagnoses. The authors inject oily Dionosil through a catheter or use Fariñas' technic of "mucosography" (see *Radiology* 39: 84, 1942; 51: 491, 1948), spraying the bronchial tree with Lipiodol. The positive bronchographic signs described are: (1) the "stop" sign, due to complete obstruction of the bronchus by the mass; (2) irregularities and ulcerations of the bronchial wall in the vicinity of the main lesion; (3) intraluminal filling defects in the presence of incomplete obstruction; (4) concentric narrowings of the bronchus in infiltrative cases.

Tomography is considered of great value, especially in cases of cavitation and in the study of peripheral nodular lesions. In cancer associated with abscess formation, bronchography permits a more specific diagnosis.

Based on the x-ray findings, the 133 cases are classified as follows:

1. Infiltrative form: 71 cases (lobar infiltration, 26; hilar infiltration, 6; lobar atelectasis, 24; prominent hilus associated with atelectasis, 15). In 5 of these 71 cases obstructive emphysema was the most evident sign.
2. Nodular form: 33 cases (hilar, 1; lobar, 32).
3. With abscess formation: 13 cases.
4. Pancoast tumor: 8 cases.
5. Associated with tuberculosis: 4 cases.
6. Associated with lung cyst: 4 cases.

Twenty-two roentgenograms; 1 photograph; 2 tables.

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Primary Sarcoma of the Bronchus and Lung. Lew A. Hochberg and Philip Crastopol. *Arch. Surg.* 73: 74-98, July 1956. (Jewish Hospital of Brooklyn, Brooklyn, N. Y.)

The authors review the cases of primary sarcoma of the lung reported in the literature between 1944 and 1954 and present 6 additional cases of their own. The majority of bronchopulmonary sarcomas fall into five categories, as follows:

1. Fibrosarcoma
2. Malignant lymphomas
 - (a) Lymphosarcoma
 - (b) Hodgkin's disease
 - (c) Reticulum-cell sarcoma
3. Leiomyosarcoma
4. Carcinosarcoma
5. Miscellaneous sarcomas
 - (a) Chondrosarcoma
 - (b) Lipomyxosarcoma
 - (c) Angiosarcoma
 - (d) Malignant giant-cell sarcoma

A total of 77 cases, including the 6 previously unreported, are considered. Of this total, 27 (35.1 per cent) were fibrosarcomas. The patients in this group varied in age from nine to sixty-six years. There were no characteristic symptoms, nor were the roentgen findings distinctive. In some the lesion was rounded and circumscribed, while in others it was diffuse. The histopathologic appearances do not differ from fibrosar-

comas found in other parts of the body. Nineteen of the 27 patients were operated upon, with a duration of life of from twenty-four days to eight years after surgery.

In 26 patients (33.8 per cent) a diagnosis of malignant lymphoma of the bronchopulmonary system was made. Fourteen, ranging in age from thirty-four to seventy years, had lymphosarcoma. Four of these patients were asymptomatic. In the other 10 patients symptoms had been present for four weeks to seven years. The roentgenographic appearances of bronchopulmonary lymphosarcoma are not characteristic. The tumor may appear as a discrete peripheral, central, or hilar mass. Strand-like areas of infiltration may extend from the hili into the lungs. Surgery was undertaken in 10 cases. One patient with a postoperative recurrence was treated by irradiation, with disappearance of the lesion. Nine patients, of whom the majority were less than thirty years of age, had primary bronchopulmonary Hodgkin's disease. The roentgenographic appearance consists typically in an infiltration or a mass within the lung. When the mass is located in the hilar region, distal atelectasis may be present. The tumor may undergo necrosis and cavitation. In 3 patients (3.9 per cent) a diagnosis of reticulum-cell sarcoma was made. The roentgenographic studies in all 3 showed a cyst or cyst-like mass. Pathologic studies revealed a rim of viable neoplastic cells at the periphery of the cyst, with central necrosis.

Thirteen cases (16.9 per cent) of pulmonary leiomyosarcoma are included. The ages of these patients ranged from six to sixty-seven years. Roentgenographic studies frequently disclosed a solitary, circumscribed density with minimal infiltration in the surrounding lung.

A diagnosis of primary carcinosarcoma was made in 5 patients (6.7 per cent of the total series of sarcomas). The roentgenographic manifestations were not characteristic. The lesion was removed surgically in 4 of the 5 patients: 1 died shortly after operation, and the other 3 were apparently well eighteen months, three, and six years after the operation.

In this group of 77 patients, there were 2 with lipomyxosarcoma, 2 with chondrosarcoma, 1 with an angiosarcoma, and 1 with a malignant giant-cell sarcoma of the lung.

In considering the entire series, it was felt that the symptoms were related to the location of the tumor rather than the morphology. Approximately 10 per cent of the cases were asymptomatic. The diagnosis of this condition is histopathological rather than clinical.

Four roentgenograms; 3 photographs; 2 tables.

DEAN W. GEHEBER, M.D.
Baton Rouge, La.

Calcification Within the Solitary Pulmonary Nodule. A Fallible Sign of Benignity. Edgar W. Davis, Sol Katz, and J. Winthrop Peabody, Jr. *Am. Rev. Tuberc.* 74: 106-111, July 1956. (Georgetown University School of Medicine, Washington, D. C.)

The presence of calcium within a solitary pulmonary nodule usually indicates that the nodule is benign. The authors report a case in which a nodule containing a small amount of calcium was observed in the apex of the right lung. The patient had previously undergone craniotomy with removal of a right parietal lobe tumor, which proved to be a metastatic anaplastic squamous-cell carcinoma. The primary site was undetermined.

The pulmonary nodule increased slightly in size over a period of two and one-half months and was then removed at the patient's insistence after it had been explained to her that it possibly represented a primary tumor. It proved to be a squamous carcinoma and a roentgenogram of the specimen showed mottled calcification within it. The patient subsequently returned to the hospital with signs of recurrent cerebral metastasis. At autopsy, thirteen months after removal of the pulmonary lesion, the only evidence of carcinoma was in the right temporal lobe of the brain.

In view of the findings in this case, the authors sent out questionnaires and collected a total of 155 cases in which there was calcification in a pulmonary nodule which proved to be carcinoma. Most of these nodules contained small amounts of calcification consisting of a few flecks. It is felt, therefore, that minimal calcification within a nodule does not exclude the possibility of tumor. On the other hand, nodules which are diffusely calcified or which contain laminations, an outer ring of calcium, or a central core of calcium, almost always represent granulomata and need not be excised. Nodules with minimal calcification, particularly when they are noted to increase in size, are probably best treated by excision rather than prolonged observation.

Three roentgenograms; 1 photograph.

JOHN H. JUHL, M.D.
University of Wisconsin

Acute Fulminating Histoplasmosis. George E. Fisel. *Am. J. Roentgenol.* 76: 60-63, July 1956. (416 Pine St., Williamsport, Penna.)

Acute fulminating histoplasmosis is an infrequent form of the disease, accounting for about 5 per cent of the cases. Two examples are reported by the author, both occurring in North Central Pennsylvania.

The roentgenograms showed diffuse, multiple nodular densities throughout both lung fields. The differential diagnosis included miliary tuberculosis, fungus disease, and diffuse bronchopneumonia. Because the second patient had worked with fluorescent lights, beryllium granulomatosis was also considered, but was ruled out when it was found that the use of beryllium in the fluorescent lamp industry had been generally discontinued in 1949. The clinical picture did not suggest silicosis or diffuse metastatic disease.

In addition to the diffuse nodular densities frequently observed, the hilar lymph nodes may be enlarged. A small percentage of patients have fever, cough, weight loss, fatigue, and rales. Organisms are more likely to occur in the sputum or gastric washings if symptoms are present, but are difficult to recover. The complement-fixation test is positive early, but decreases rapidly in a period of weeks. The patient becomes sensitive to histoplasmin a few weeks after the initial infection.

The roentgen findings resolve slowly, and it is said that three to five years may be required for the deposition of calcium in the caseating areas.

Six roentgenograms. FRANK T. MORAN, M.D.
Auburn, New York

Pneumocystis Carinii Pneumonia in an Infant. Georges Dauzier, Thayer Willis, and Roy N. Barnett. *Am. J. Clin. Path.* 26: 787-793, July 1956. (Norwalk Hospital, Norwalk, Conn.)

A twenty-one-month-old white boy, born and reared in Connecticut, died from pneumonia caused by the

parasite *Pneumocystis carinii*—so-called plasma-cell pneumonia [see Sternberg and Rosenthal: *J. Pediat.* 46:380, 1955. Abst. in *Radiology* 66:294, 1956].—The diagnosis was made postmortem by identification of the causal agent in sections of lungs impregnated with silver. Although numerous instances of this illness have been observed in Europe, no previous case has been reported as originating in the United States. Recognition of this infection is based chiefly on histopathologic findings, but clinical diagnosis should be feasible when the entity is better known. The radiographic findings usually consist of scattered, small bilateral shadows that seem to spread outward from the hilar region of the lungs, later becoming confluent. Such signs may precede the clinical symptoms. If the condition is suspected, properly performed studies of sputum may result in recognition of the etiologic agent antemortem.

Two roentgenograms; 3 photomicrographs.

Kartagener's Triad (Situs Inversus, Bronchiectasis and Sinusitis). Report of a Case. David L. Deutsch. *Dis. of Chest* 30:231-233, August 1956. (U. S. Army Hospital, Fort Knox, Ky.)

Kartagener's triad consists of bronchiectasis, chronic sinusitis, and situs inversus. The author reports a case with a coincidental diagnosis of rheumatic fever in a twenty-one-year-old male.

Four roentgenograms. HENRY K. TAYLOR, M.D.
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Role of Sinusitis in Bronchiectasis. R. M. Versteegh and J. Swierenga. *J. franç. de méd. et chir. thorac.* 10:581-590, 1956. (In French) (Hôpital Saint-Antoine, Utrecht, Holland)

Of 134 patients suffering from bronchiectasis, 36 per cent were found to have maxillary sinusitis when studied by radiographs and antral puncture. In bronchiectasis on a constitutional basis, i.e., with generalized changes in one or both lungs, as in Kartagener's triad of bronchiectasis, sinusitis, and situs inversus, it is noted that sinusitis is present in 66 per cent of adults and children. In local bronchiectasis involving the lower lobes and the lingula or right middle lobe, sinusitis is secondary to bronchiectasis in 33 per cent of the cases, but is only rarely present in children.

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University of Minnesota

Mediastinal Tumors in Children. Edward B. Singleton and E. Wiley Biles. *Texas State J. Med.* 52:588-595, August 1956. (E. W. B., 6621 Fannin St., Houston 25, Texas)

In contrast to the findings in adults, most mediastinal masses in children are benign. The most common of these, at least under two years of age, is of course the normal thymus. Abnormal masses may be of congenital, inflammatory or neoplastic origin. A few malignant tumors occur, mostly metastatic.

Eight cases are presented. Included are 3 benign tumors (cystic hygroma, thymoma, and ganglioneuroma) and a malignant neoplasm, neuroblastoma, without recurrence two years after x-ray therapy. A gastric duplication cyst, cardiopasm, aortic aneurysm, and a mass of tuberculous lymph nodes make up the remainder.

Twenty-one roentgenograms; 1 table.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

THE CARDIOVASCULAR SYSTEM

Status of Fifty Patients Four and a Half to Seven Years after Mitral Commissurotomy. O. Henry Jan-ton, Julio C. Davila, and Robert P. Glover. *Circulation* 14:175-184, August 1956 (Presbyterian Hospital, Philadelphia, Penna.)

Of the authors' first 50 mitral commissurotomy patients, 41 were alive at the time of this report, having been followed for four and a half to seven years. Nine died either immediately after surgery or from six weeks to three years later. Of the living, the authors considered 29 to be improved in varying degrees as a result of surgery, though from the point of view of the patients and/or their family doctors 36 were felt to be better than they were before operation.

Roentgen studies showed reduction of the cardiac silhouette in 10 patients; in 26 the silhouette was unchanged, and in 5 it was larger. A small group showed regression of right ventricular hypertrophy, electrocardiographically, but in the majority there was no change. Murmurs were not significantly affected. Catheterization data paralleled the clinical status. Improvement in the group without valvular calcification was much greater than in those with calcification.

Eight patients had evidence of rheumatic activity in the postoperative period. In no instance did embolization occur postoperatively; 1 embolus was observed during the operation.

The authors conclude that the procedure of commissurotomy offers a real, often remarkable benefit to the patient with mitral stenosis.

Twelve roentgenograms; 2 tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Discussion on the Clinical and Radiological Aspects of Diseases of the Major Arteries. H. H. G. Eastcott, David Sutton, and C. G. Rob. *Proc. Roy. Soc. Med.* 49:557-572, August 1956. (St. Mary's Hospital, London, England)

This discussion on diseases of the major arteries is divided into three sections. Eastcott, in the first section, discusses briefly some of the clinical aspects of aortic aneurysm, aortic thrombosis, and arterial injuries.

Aneurysms of the thoracic aorta are due, as a rule, to syphilitic aortitis or to coarctation with post-stenotic dilatation. In the abdominal aorta, aneurysms are generally on an arteriosclerotic basis. These arteriosclerotic aneurysms occur for the most part in patients over sixty, and rupture follows within weeks or months of the first abdominal pain, with a high mortality (100 per cent in the author's experience). Also discussed is an insidious thrombosis which appears to begin at a relatively early age, first involving the proximal portion of the common iliac arteries and slowly progressing to total aortic occlusion. In arterial injuries fatal hemorrhage or gangrene of the part are the two chief problems. Repair has been accomplished by anastomosing or grafting the ends forming the gap. Illustrative cases are included, with 2 figures.

The second part of the presentation, by Sutton, deals largely with radiological problems of both technic and diagnosis. Reliance for angiographic investigation is based on percutaneous technic generally carried out under local anesthesia and basal narcosis. Two basic methods are used: percutaneous needle puncture and

percutaneous arterial catheterization. In certain cases, especially in lesions involving the intrathoracic aorta and great vessels of the upper abdominal aorta, arterial catheterization is especially useful. One may catheterize *via* the femoral or the carotid artery.

In the region of the thoracic aorta and its branches one may encounter congenital lesions (coarctation, developmental anomalies of the great vessels; patent ductus); obstructive lesions (thromboses of major branches of the aorta and of the carotid and brachial arteries); aneurysms; arteriovenous fistulas. In most cases of carotid artery thrombosis, atheroma was the etiological factor. However, cases of thrombosis associated with syphilitic aortitis are reported. An interesting case was one of thrombosis of the brachial artery of traumatic etiology, due to prolonged use of a crutch.

Mention is made of a number of thoracic aneurysms investigated by thoracic aortography with satisfactory diagnostic results. There were 2 fatalities—the only ones in the author's large angiographic series. In both cases there were giant aortic aneurysms presenting through the thoracic wall or in the root of the neck.

Technics used in the abdominal aorta and its main branches are: (1) single puncture of the lumbar aorta or the femoral artery; (2) percutaneous catheterization of the aorta or iliacs from the femoral artery. The pathological conditions encountered are: congenital and developmental lesions, which include aberrant renal vessels and abdominal coarctation; obstructive lesions (thrombosis, stenosis, and emboli); aneurysms; arteriovenous fistulae; angiomas and miscellaneous lesions.

Obstructive lesions are very common in the aorta and the iliac arteries, particularly in the femoral and more distal areas. Obstruction due to an aortic thrombosis does not extend above the renal arteries as a rule, although it reaches the point of origin of the renal vessels. The author advocates serial films in aortic thrombosis to study the main channels above and below the block, as well as the anastomotic channels. The majority of cases of aortic and iliac occlusions were secondary to atheroma.

Most cases of aortic aneurysm are best investigated by lumbar aortography. Upward extension of the aneurysm seems to be limited by the renal arteries. Downward extension occurs into the iliacs but seldom below the bifurcation of the common iliac. The lumen of the aneurysm is often surprisingly small relative to the clinical mass. The chief cause of abdominal aneurysm is atheromatous disease.

If an abdominal aneurysm is unusually large, contrast medium may become diluted following injection above, and the lower extent may then be poorly defined. In such cases retrograde catheterization may be of value. Saccular aneurysm with a small neck may be difficult to visualize and may require that the catheter tip be placed opposite the aneurysmal neck.

Arteriovenous fistulae may offer difficulties in visualization because of the rapid shunt of blood. Therefore, larger quantities and greater concentration of the medium are required. Serial films must be made very rapidly, since most of the contrast material will be in the venous system within a second of the termination of injection.

This contribution is illustrated by 26 roentgenograms and 2 photographs.

In the concluding part of the discussion, Rob covers

treatment and results, restricting himself to those surgical procedures which aim at restoring the blood flow through an occluded artery or reconstructing the vessel after removal of the aneurysm. He feels that conservative treatment is to be preferred in obliterative vascular disease, with direct surgical operations justified in only a small number.

In a series of 180 direct operations upon the arteries, the results were found to improve with better selection. "In occlusive disease this must be strict, but in patients with aneurysms, injuries, etc., we are advising operation more and more frequently." F. F. RUZICKA, JR., M.D.
St. Vincent's Hospital, New York

Congenital Aortic Stenosis: Clinical Aspects and Surgical Treatment. Daniel F. Downing. *Circulation* 14: 188-199, August 1956. (Hahnemann Medical College, Philadelphia, Penna.)

Thirty-seven patients with congenital aortic stenosis (29 males and 8 females, ranging in age from four months to thirty-nine years) form the basis of the author's report. Four had associated coarctation and 3 had mild pulmonary stenosis.

Fatigue, dyspnea, profuse perspiration, and syncope were the more common symptoms. Sudden unexplained death occurred in 3 patients. On physical examination the outstanding sign was the harsh systolic murmur, best heard in the second, third, or fourth right interspace.

The most consistent roentgen abnormality was dilatation and anterior prominence of the ascending aorta in the left anterior oblique view. This finding was definite in 29 of this series and questionable in 1 other. In 16 patients there was some enlargement of the right ventricle, and in 7 some degree of left atrial enlargement.

Brachial artery tracings were obtained in most cases and were always abnormal, with the slow systolic rise expected in aortic stenosis.

Nineteen patients were operated upon, with 2 deaths. Improvement was observed in all but one of the remainder, who had an infundibular type of stenosis. One patient improved temporarily, but later signs of insufficiency developed.

The author believes that surgical dilatation is indicated regardless of age if one or more of the following criteria are present: (1) fatigue, syncope, or dyspnea; (2) ECG evidence of left ventricular hypertrophy; (3) pulmonary hypertension in the absence of other lesions; (4) a systolic gradient of 50 mm. Hg or more, measured by left heart catheterization, with normal or decreased cardiac output.

Eight roentgenograms. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Angiocardiography in the Diagnosis of Saccular Aneurysm of the Abdominal Aorta. Report of a Case. Israel Steinberg and Nathaniel Finby. *New England J. Med.* 255: 204-207, Aug. 2, 1956. (Cornell University Medical College, New York, N. Y.)

Although visualization of the entire abdominal aorta by angiocardiography is usually unsatisfactory because of insufficient opacification, aneurysms in the thoracolumbar portion of the aorta, particularly when multiple films are used, may be expected to be well demonstrated. The preoperative diagnosis becomes important in the case of saccular aneurysm of this portion of the aorta, since it permits adequate planning of surgical excision with or without grafting.

The authors report the case of a 51-year-old Negroess with an arteriosclerotic saccular aneurysm of the aorta eroding the bodies of the twelfth dorsal and first lumbar vertebrae. Bone erosion by arteriosclerotic aneurysm of the abdominal aorta is rare, since the elongation, dilatation, and tortuosity of the vessel usually prevent its contact with the spine. Nevertheless, in this instance all serologic and spinal fluid tests were negative for syphilis, and microscopic examination of the resected sac revealed no stigma of that disease.

Angiocardiography was performed in the frontal and lateral views with the patient reclining on a Fairchild roll-film magazine. Eight and a half seconds after the injection was begun exposures were made at half-second intervals. The films demonstrated the large saccular aneurysm containing laminated clot.

Five roentgenograms; 1 photograph; 3 drawings.

SAUL SCHEFF, M.D.

Boston, Mass.

Pulmonary Arteriovenous Aneurysm. A Report of Six Cases. Ralph J. Schlosser and Henry N. Harkins. *Am. J. Surg.* 91: 872-879, June 1956. (H. N. H., University of Washington School of Medicine, Seattle, Wash.).

Six cases of pulmonary arteriovenous aneurysm, in patients ranging from eighteen months to sixty years, are presented; 3 were proved by surgery and 3 diagnosed on the basis of the history and x-ray appearance. Five of the patients gave a family history of epistaxis or cutaneous telangiectases. The more common symptoms were dyspnea, cyanosis, clubbing, nervous aberrations, chest pain, hemoptysis, epistaxis, telangiectasis, and a murmur over the lesion. The erythrocyte count was increased and arterial oxygen saturation was diminished.

Chest films often demonstrate a dense rounded shadow, most often in the middle or lower lobe or lingula, connected to the hilus by a vascular band. Fluoroscopy to show pulsation of the lesion, Valsalva and Müller tests for change in its size, and tomography are sometimes of help in diagnosis. Angiocardiography may demonstrate shunts otherwise unrecognizable.

Excision of the lesion is indicated in symptomatic cases, and perhaps in some asymptomatic cases, because of the possibility of lethal hemoptysis or hemothorax.

Five roentgenograms. CAPT. GARTH R. DREWRY

U.S.A.F. Hospital, Tampa, Fla.

Arterial Disease as a Cause of Pain in the Buttock and Thigh. George Bonney. *J. Bone & Joint Surg.* 38-B: 686-691, August 1956. (Institute of Orthopaedics, London, England)

Pain in the buttock or thigh is most frequently thought of in terms of orthopedic interest. The possibility of arterial disease as the exciting cause is often overlooked.

A series of 10 cases is reported in which pain in the buttock or thigh was found to be due to arterial obstruction, though all the patients were originally treated for osteoarthritis of the hip or lumbosacral disk degeneration. The pain is of the same type as that described in vascular occlusions of the limbs elsewhere and is identical in nature with that affecting the calf in classical intermittent claudication. It follows a constant pattern, coming on after walking a short distance, with relief at rest.

Gluteal and sciatic pain may be the result of aortic or

common iliac obstruction. Pain in the front of the thigh may be caused by external iliac occlusion, as well as by common iliac obstruction. Palpable tibial pulses do not exclude a diagnosis of vascular insufficiency, nor are ischemic changes in the limbs a frequent finding.

Radiography, by showing calcification at the site of the great vessels, is often of aid in diagnosis. Abdominal aortography will effectively outline the great vessels and demonstrate points of occlusion.

Six roentgenograms. JOHN F. RIESSER, M.D.

Springfield, Ohio

Congenital Peripheral Arteriovenous Communications. Use of Femoral Artery to Heart Circulation Time in Diagnosis. Thomas O. Murphy, Sol Sandhaus, and Joseph M. Ryan. *Minnesota Med.* 39: 389-391, June 1956. (Medical School, University of Minnesota, Minneapolis, Minn.)

Although traumatic arteriovenous communications are easily detected, this is not true of small congenital communications. Even though the blood flow through a single lesion is small, the total potential of numerous shunts can be quite large. In estimating the total volume of these shunts, methods utilizing blood gas analysis or arteriography may be used, but these involve expense and inconvenience. The authors have found a technic using radioactive iodine tracer element to be simple, safe, and accurate.

Thirty to forty microcuries of I^{131} -labeled serum albumin in sterile saline is injected rapidly into the femoral artery, with the patient in the basal state. A scintillation counter, well collimated, is placed over the right auricle of the heart. The interval from injection to appearance of radioactivity in the right auricle is recorded, by both a rate meter and a graphic recorder. The appearance time in the normal adult is 20.0 to 25.2 seconds. The figure for small children is less, that for an infant three months of age being 9.0 seconds. In 5 patients with abnormal shunts the femoral artery-to-heart appearance time varied from 1.0 to 8.8 seconds. There is no obvious correlation between the radioactivity curve at the right auricle and the degree of involvement of an extremity with arteriovenous malformations.

Two roentgenograms; 3 graphs; 1 table.

In Vivo Visualization of Intracardiac Structures with Gaseous Carbon Dioxide. Cardiovascular-Respiratory Effects and Associated Changes in Blood Chemistry. M. J. Oppenheimer, T. M. Durant, H. M. Stauffer, G. H. Stewart, III, P. R. Lynch, and Frank Barrera. *Am. J. Physiol.* 186: 325-334, August 1956. (Temple University School of Medicine and Hospital, Philadelphia, Penna.)

Carbon dioxide gas was injected (a) intravenously, (b) into the left heart, and (c) into the peripheral end of the carotid artery. Resulting cardiovascular and respiratory changes were observed by cinefluorography and by measurements of pressure pulses in various locations. Blood and respiratory gas changes were also observed. All changes were minimal (seconds duration) when the gas was introduced on the right or left side of the circulation. Injection into the peripheral carotid produced no untoward effects. The gas gave good visualization of valves and great vessels. Body position was not an important factor in mortality and morbidity.

Carbon dioxide is a safe contrast medium for *in vivo*

study of intracardiac structures. The gas has been used successfully by intravenous injection in human cases (2 hydranencephalic infants; multiple porencephalic cysts).

Five roentgenograms; 4 graphs; 2 tables.

THE BREAST

Periodic Roentgenographic Studies of a Growing Human Mammary Cancer. Helen Ingleby and Lolita Moore. *Cancer* 9: 749-752, July-August 1956. (Albert Einstein Medical Center, Northern Division, Philadelphia, Penna.)

The authors, when faced with a patient who refused any type of treatment for carcinoma of the breast, turned defeat into opportunity by enlisting the patient's co-operation in obtaining periodic observation of the natural course of the disease. On each of four visits covering a period of almost two years, soft-tissue roentgenograms of the breast were obtained, which showed the size, shape, and pattern of growth of the primary tumor. Paraffin and slicer sections of the subsequent mastectomy specimen verified the roentgen findings.

The authors are to be commended on utilizing a commonly overlooked source of material for the study of human cancer.

Four roentgenograms; 2 photographs.

JAMES E. BAUER, M.D.
University of Missouri

HERNIA

Radiologic Diagnosis of Hiatus Hernia. Leslie K. Sycamore. *Gastroenterology* 31: 169-189, August 1956. (Mary Hitchcock Memorial Hospital, Hanover, N. H.) The lower esophagus and esophagogastric junction are as yet incompletely understood and many points regarding the basic anatomy and physiology of this region remain in dispute. There is no agreement on the mechanism of closure of the cardia, on the presence of a cardiac sphincter or of a lower esophageal sphincter, or on the location of the esophagogastric junction. This complicates the radiologic diagnosis of hiatus hernia.

A coarse, irregular mucosal pattern above the diaphragm, except in a vestibule, usually indicates hernia. The gastroesophageal vestibule is apparent as a small residue of barium at the lower end of the esophagus after the remainder has been emptied by a peristaltic wave. The esophageal ampulla is the normal expansion of the lower esophagus produced by the pressure of the advancing peristaltic wave acting against the resistance of the cardia. The ampulla may closely resemble a hernia. Under fluoroscopic observation, however, peristaltic waves pass smoothly through the ampulla, which is obliterated except for a possible temporary residue in the vestibule. With hernia, the pouch may at times empty in sequence to esophageal peristalsis, but some of the waves stop at the esophagogastric junction and leave the hernia filled. Another point of differentiation is retrograde filling of the hernia from the stomach, associated with widening of the hiatus. The hernia is then demonstrated as a sharply delineated sac which is entirely different from reflux of barium into the esophagus. If an ampullary groove is present, peristalsis passes through it to distinguish it from the esophagogastric junction of a hernia.

Careful technic is of importance in the demonstration

of hernia. The patient must be examined in the erect and various recumbent positions. Spot-films are essential. The Valsalva maneuver is useful to increase intra-abdominal pressure. In obscure cases the esophagogastric mucosal junction may be localized by the application of silver clips through the esophagoscope. Several possible pitfalls in diagnosis are mentioned. A large ampulla may obscure a small hernia, the hernia becoming visible only after the ampulla has emptied. A diverticulum of the lower esophagus may simulate a hernia.

Esophagitis is a common complication of hiatus hernia, and is probably responsible for most of the symptoms. The digestive action of the gastric juice on the esophageal mucosa results in ulceration and an inflammatory reaction. The esophageal ulcers are usually shallow and are not readily demonstrated. Peptic ulcer frequently occurs, however, on the gastric side of the esophagogastric junction and is more easily shown.

A complete classification of hiatus hernias is offered as a possible simplification from the radiologic viewpoint: (1) Rolling (para-esophageal); (2) sliding, including (a) eccentric (para-esophageal) and (b) concentric (short esophagus type); (3) congenital short esophagus.

Seventy-two roentgenograms; 4 diagrams.

JOACHIM GFOELLER, M.D.
Cleveland City Hospital

THE DIGESTIVE SYSTEM

Some Diagnostic Difficulties in Cases with Cascade Stomach and Chronic Gastric Volvulus. Paul M. Davies. *Brit. J. Radiol.* 29: 423-426, August 1956. (St. Luke's Hospital, Guildford, Surrey, England)

Chronic gastric volvulus and cascade stomach may offer difficulties in diagnosis. Kinking, rotation, or torsion of the stomach may obscure areas which are normally easily accessible to fluoroscopic examination. Not only may organic lesions be hidden, but in other situations they may be simulated when in reality they are not present. Five cases, 1 of cascade stomach and 4 of chronic gastric volvulus, are presented with accompanying radiograms to illustrate the problems involved.

Six roentgenograms. STEPHEN N. WIENER, M.D.
Mt. Sinai Hospital, Cleveland

Pancreaticosplenectomy Combined with Gastrectomy in Cancer of the Stomach. Komei Nakayama. *Surgery* 40: 297-310, August 1956. (Chiba University, School of Medicine, Chiba, Japan)

Attention is focused upon a method of treating cancer of the stomach which involves total or partial gastrectomy with *en masse* resection of the body of the pancreas and spleen, the pancreas being transected at the neck, leaving only the head of the gland in normal position. The author believes this procedure should be employed more extensively in suitable cases. He has used it in 113 patients and in a series of animal experiments with about 100 dogs. Although the article is primarily concerned with the operative technic and results, the section on diagnosis is of radiologic interest.

Competent roentgen studies are essential to determine in which cases the operation is indicated. If the carcinoma originates in the cardiac portion or the body of the stomach and has infiltrated more than 5 cm.

along the lesser curvature, the possibility of carrying out the combined procedure should be considered; if the tumor has infiltrated more than 7 cm. along the lesser curvature, pancreatocystectomy with gastrectomy is definitely indicated. This conclusion is reached on the basis of the author's observations on 110 patients. Infiltration extending more than 5 cm. along the lesser curvature was found to be associated with involvement of the parapancreatic and splenic hilar nodes in 70 to 80 per cent of the cases, while with more than 7 cm. infiltration there was a 100 per cent incidence of nodal involvement.

Another method of evaluating the degree of retroperitoneal infiltration is transperietal splenovenography, which has been carried out in 120 patients with cancer of the stomach. Stenosis, abnormal flexion of the vein, retrograde flow or stagnation of the venous blood, pressure on the vein by the adjacent structures, and irregularity of the venous wall are all suggestive of carcinomatous invasion toward the retroperitoneal space. Intelligent interpretation of these findings adds another important means of determining the suitability of a case for the combined procedure. Marked abnormalities often indicate that pancreatocystectomy is no longer feasible.

Radiophosphorus has also been helpful in determining whether cardiectomy or total gastrectomy is the procedure of choice in cancer of the cardia. About four hours after the hypodermic administration of 300 or 500 μ c of P^{32} , laparotomy is performed and the activity of each group of lymph nodes is measured with a tiny Geiger-Müller counter. If a count of 1.2 or more times normal is obtained, the nodes should be removed as far as possible, for in the majority of them cancerous involvement will be found on histologic study.

Twelve figures; 7 tables.

Closed Loop Obstruction of the Afferent Limb. A Late Complication of Antecolic Partial Gastrectomy. N. Hajdu, M. A. Harris, and Gordon S. Ramsay. Brit. J. Radiol. 29: 418-422, August 1956. (St. George's Hospital, London, S. W. 1, England)

Although rare, mechanical obstruction of the afferent limb is an important complication following Polya resection and antecolic anastomosis. Three types of obstruction occur: (A) herniation of the small bowel through the gap between the anastomosis and the transverse colon; (B) volvulus, kinking or strangulation of the long afferent loop, which has moved behind the efferent loop; (C) obstruction resulting from constricting bands, local postoperative adhesions, or traction and displacement of the greater omentum.

Two cases are presented, with accompanying radiographs, illustrating type B and type C. In the first case postoperative adhesions resulted in organo-axial volvulus of the gastric remnant associated with mesenterio-axial volvulus of the anastomosing loop. The roentgen diagnosis was based on: (a) complete obstruction at the stoma, with torsion of the rugae visible in the Trendelenburg position; (b) narrowing of the transverse colon below the stomach by pressure on the anastomosing loop; (c) pseudo-tumor encompassed by the gas-filled colon; (d) absence of pathologic fluid levels.

The second case illustrates obstruction of the afferent limb near the duodenojejunal junction due to postoperative adhesions. Characteristic x-ray signs were: (a) pseudo-tumor shadow of speckled density; (b) down-

ward displacement of the transverse colon; (c) absence of pathologic fluid levels.

Four roentgenograms; 7 drawings.

STEPHEN N. WIENER, M.D.
Mt. Sinai Hospital, Cleveland

Intussusception in Adults. David L. Dean, F. Henry Ellis, Jr., and William G. Sauer. Arch. Surg. 73: 6-11, July 1956. (Mayo Foundation, Rochester, Minn.)

Ninety-six cases of intussusception in adults were encountered between January 1910 and January 1955 at the Mayo Clinic. Symptoms in this older group are usually less severe and less dramatic in onset than in children. Only 13.5 per cent of the cases studied presented the picture of acute intestinal obstruction. The symptoms were usually of several months duration. They included cramps, constipation, diarrhea, melena, weight loss, and vomiting. Intermittent cramping pain occurred in 73 per cent of the cases.

While the ileocecal type of intussusception predominates in infants, the location is more evenly divided among the various parts of the bowel in the adult. In 87.5 per cent of the cases an organic lesion was found to explain the intussusception. Of the 84 lesions, 58 (69 per cent) were malignant.

The roentgen examination is often diagnostic. At times, a plain film of the abdomen will show a sausage-shaped homogeneous shadow outlined by two stripes of air or by concentric rings representing the air-filled sheath. A barium enema may demonstrate the lesion typically by showing two parallel bands of barium connected by concentric rings, giving the so-called "coiled spring" appearance. At times the barium may stop suddenly, with formation of a cap corresponding to the head of the intussusception.

The various methods of treatment are discussed, and 2 typical cases are presented. The high incidence of organic lesions makes surgery mandatory for intussusception in adults.

Two roentgenograms; 1 photograph; 4 tables.

DEAN W. GEHEBER, M.D.
Baton Rouge, La.

Congenital Intrinsic Duodenal Obstruction. Report of 32 Cases. Thomas C. Moore. Ann. Surg. 144: 159-164, August 1956. (Department of Surgery, Indiana University Medical Center, Indianapolis, Ind.)

The author presents a statistical review of 32 consecutive cases of congenital intrinsic duodenal obstruction. Duodenal stenosis or atresia is responsible for virtually all duodenal obstruction in the early days of life. Extrinsic obstructions, such as are produced by annular pancreas and anomalies of intestinal rotation and fixation, generally do not appear until somewhat later.

Symptoms of complete obstruction from birth were encountered in all cases of atresia and in one-half of those of stenosis. Atresia was found more frequently in proximal duodenal obstructions, whereas a distal obstruction was more likely to be due to stenosis.

The plain x-ray film of the abdomen is regarded as the most reliable single diagnostic measure. The distention of the stomach and the duodenum with air up to the point of obstruction is clearly shown in most cases. The absence of air in the intestine beyond the point of obstruction is also noteworthy. When the stomach and duodenum are distended and small amounts of air are also found in the rest of the intestine, a diagnosis of

stenosis is suggested. In some cases with symptoms of incomplete obstruction, it may be desirable to investigate the duodenum and upper small bowel by giving small amounts of Lipiodol by mouth. This may aid in identifying an area of obstruction which one may not be able to show by other means.

Twenty-five per cent of the infants constituting this series were premature. Additional congenital anomalies were discovered in 41 per cent. Of these, imperforate anus was seen most frequently (4 cases). Malrotation of the intestine occurred in 3 cases, and esophageal atresia with tracheo-esophageal fistula, mongolism, congenital heart disease, and annular pancreas in 2 cases each.

Twenty-one patients were treated by operation during the past fourteen years. Eighteen recovered (86 per cent) and 3 died (14 per cent). Two of the 3 deaths were of premature infants with additional congenital anomalies.

Four roentgenograms; 5 tables.

THEODORE E. KEATS, M.D.
University of Missouri

The Syndrome of Mesenteric Vascular Compression of the Duodenum. Report of Eleven Cases with Operative Correction. Sidney A. Rosenberg and Arnold Sampson. *Arch. Surg.* 73: 296-304, August 1956. (Montefiore Hospital, Pittsburgh, Penna.)

Compression of the distal portion of the duodenum by the superior mesenteric artery has been recognized as an entity for about one hundred years. The symptoms reflect duodenal stasis and distention and are especially likely to be encountered in thin, asthenic patients.

Roentgenologic recognition is based upon to-and-fro regurgitation of barium within the duodenal loop, dilatation and retention in the loop, sharp cut-off of the duodenal shadow a little to the right of the spine, and moderate gastric retention of barium regurgitated from the duodenum.

Many surgical procedures have been tried for relief of the syndrome. The authors advocate simple duodenojejunostomy and report 11 cases in which symptoms were relieved by that procedure. Most of the patients had previously been labeled as neurotic. Selection of cases for operation obviously requires careful clinical and roentgenographic judgment.

Six roentgenograms; 3 drawings.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Primary Carcinoma of the Infrapapillary Portion of the Duodenum. Jacob Rabinovitch, Joseph I. Anton, Phineas Rabinovitch, and Nathan Mitchell. *Arch. Surg.* 73: 290-293, August 1956. (J. R., Crown Heights Hospital, Brooklyn, N. Y.)

Two case reports are presented of carcinoma of the infrapapillary portion of the duodenum, and the clinical aspects of such cases are discussed. About 18 per cent of duodenal carcinomas arise distal to the ampulla of Vater, and their diagnosis has not often been made except at operation or autopsy.

The symptoms depend essentially upon location of the growth. Radiological investigation is of considerable aid in diagnosis and is a necessity for exact determination of the site of the tumor. In one of the authors' cases an upper gastrointestinal series disclosed distention of the stomach and duodenum, which terminated abruptly with a constriction ring just proximal

to the duodenojejunal junction. In the second case, also, there was an encircling lesion in the terminal portion of the duodenum. The authors state that, if looked for, the lesion can scarcely be missed. They advocate serial studies of the duodenum when the diagnosis is suspected and conventional x-ray studies have been non-contributory.

Surgical resection of the distal duodenum is evidently feasible in many patients. The slow growth characteristic of this tumor makes the postoperative outlook quite hopeful.

Two roentgenograms; 1 photograph; 1 photomicrograph.
DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Roentgenographic Manifestations of Congenital Megacolon (Hirschsprung's Disease) in Early Infancy. Carroll Z. Berman. *Pediatrics* 18: 227-238, August 1956. (25 Bennet St., Boston 11, Mass.)

Early diagnosis of congenital megacolon in infancy may be essential not only in differentiating the lesion from organic obstruction of the large or small bowel but in the institution of proper therapy when little or no meconium is passed in the neonatal period, with consequent danger of death from obstruction.

The author reviewed the x-ray findings during the first month of life in 23 infants with this disease. The diagnosis was proved histologically in each instance. Clinically all 23 had abdominal distention and 20 had severe constipation. In 16 vomiting was an important feature. The lesion began proximally at the rectosigmoid or sigmoid level in 17; at the splenic flexure in 2; in the low descending colon in 2; in the proximal ascending colon in 1; and in the terminal ileum in another.

In 18 of the series plain films showed slight to moderate gaseous distention of intestinal segments which were usually identifiable as loops of colon. In 12 there were prominent fluid levels within the colon. In the normal children studied for comparison distention was less, it was confined chiefly to the small intestine, and no fluid levels were encountered. In the occasional case where the distention could not be definitely localized from the recumbent and erect films, views in the inverted position were of value, particularly when rectal stenosis or atresia was suspected.

Nineteen of the 23 cases were studied by barium enema. In 15 the findings were diagnostic. The diagnosis depends upon the visualization of a distal segment of colon which is persistently narrow relative to the next proximal portion. This is best demonstrated fluoroscopically with varying degrees of rotation. Postevacuation study may demonstrate the luminal discrepancy more effectively. If the immediate studies are equivocal, follow-up examination at twenty-four and forty-eight hours will show unusual retention of the barium. Patience must be exercised in inserting the tube, since placing it too high in the rectal canal may fail to show a lower area of narrowing.

The enema can be misleading when the aganglionic segment is very short or if the proximal onset of the deficiency is in the cecum or ileum, where the luminal discrepancy will be difficult to demonstrate. In these cases the one finding suggestive of the disease is the retention of barium for days after the examination despite repeated cleansing enemas. When the degree of narrowing, or achalasia, of the involved segment is mild, the change in diameter may be difficult to appreci-

ate. A third limiting factor of the barium enema study is the age of the patient, since the deformity becomes more readily apparent as the infant matures. In the author's experience, however, the site of the lesion was a more serious factor, the detection of the achalasia being more difficult when a short segment in the rectum is involved or where the deficiency begins in the terminal ileum or cecum.

Nineteen roentgenograms; 1 table.

SAUL SCHEFF, M.D.
Boston, Mass.

Pneumatosis Involving the Left Side of the Colon.

Richard H. Marshak, S. Daniel Blum, and Joan Eliasoph. *J.A.M.A.* 161: 1626-1628, Aug. 25, 1956. (R. H. M., 1075 Park Ave., New York, N. Y.)

In a review of 213 cases of pneumatosis cystoides intestinalis found in the world literature, the authors discovered only 40 in which colonic involvement was reported, and of these only 13 in which the large intestine and its peritoneal attachments were solely affected. They report 4 cases, 1 of which appears to have been published earlier (Marshak *et al.*: *J.A.M.A.* 148: 1416, 1952. *Abst. in Radiology* 60: 309, 1953). Three of these cases involved the sigmoid, and in all of these sigmoidoscopy was done, with biopsy in two.

Because there are no specific clinical or laboratory findings to indicate the presence of a left-sided pneumatosis coli, the diagnosis must be made by radiographic or surgical means.

A preliminary film of the abdomen revealed, in one patient, a grape-like cluster of air shadows that shifted position within the abdominal cavity. The nature of these alterations was obscure until a barium enema showed them to be gas cysts along the course of the sigmoid, the mesentery of which was elongated. In the other patients, gas pockets along the course of the descending and sigmoid colon, as well as in the mesentery, were observed, and their true nature could be suspected. In none was there evidence of pneumoperitoneum. The alterations were best visualized in barium studies of the colon.

Unless the gas cysts are recognized as such, the condition may be confused with polyposis, ulcerative colitis, or carcinoma.

Eleven roentgenograms.

The Clinical Significance of Air and Barium in the Biliary Tract. Earl J. Halligan and Julius J. Baber. *Arch. Surg.* 73: 66-73, July 1956. (E. J. H., 254 Montgomery St., Jersey City 2, N. J.)

Air or barium in the biliary tract indicates either an internal biliary fistula or an incompetent sphincter of Oddi with regurgitation. The commonest cause of an internal biliary fistula is erosion of a gallstone into an adjacent viscus, usually the duodenum or colon. Other causes are perforation of a duodenal ulcer, with secondary erosion of the biliary tract and carcinoma of the gallbladder.

A number of factors may lead to an incompetent sphincter of Oddi. Among these are adhesions producing traction on the sphincter (a) following surgery in this region, (b) with intra-abdominal masses, (c) with pancreatitis, (d) with perforated duodenal ulcer, and (e) with cholecystitis and pericholecystitis. Tumors may produce induration of the sphincter and keep it patent. Other causes include (1) marked antiperistalsis of the duodenum, (2) patency of the sphincter

following passage of common-duct stones, (3) disturbances of innervation with dilatation of the sphincter, (4) biliary-tract infections (non-ascending), (5) drug effects (atropine), and (6) ascending gas-forming infections.

The authors present reports of six cases of air or barium in the biliary tree. Two cases were proved to represent spontaneous internal biliary fistulae; in 2 cases the cause was not determined; in 1 case there was regurgitation through an incompetent sphincter of Oddi; and in 1 case a cholecystojejunostomy had been previously performed.

Nine roentgenograms. DEAN W. GEHEBER, M.D.
Baton Rouge, La.

Evaluation of Routine Operative Cholangiography.

Deward O. Ferris and Harry M. Weber. *Arch. Surg.* 73: 197-203, August 1956. (Mayo Foundation, Rochester, Minn.)

In the hands of the authors operative cholangiography has yielded valuable information in practically all patients in whom it has been tried. They express a preference for doing the procedure before exploration of the bile ducts. In 125 of 185 cases so handled, the biliary tract was found to be normal. In 14 cases the presence of clinically suspected common duct stones was confirmed. In 7 cases stones, not clinically suspected, were discovered. Other valuable findings were: anomalous bile ducts, residual remnant of the cystic duct, fibrosis of the sphincter of Oddi, ampullary carcinoma, and reflux of medium into the pancreatic duct.

Secondary cholangiography, performed at surgery after the common duct had been explored, showed in 45 cases that no common duct stones had been overlooked.

The authors conclude that the performance of operative cholangiography is definitely worthwhile. With the technic which they describe, it appears not to add significantly to the risks of surgery.

Four roentgenograms; 3 diagrams; 2 tables.

DON E. MATTHEISEN, M.D.
Phoenix, Ariz.

Cholangiographic Diagnosis of Pancreatitis. Maurice D. Sachs and Philip F. Partington. *Am. J. Roentgenol.* 76: 32-38, July 1956. (M. D. S., 7300 York Road, Cleveland 30, Ohio)

After a brief but comprehensive review of the anatomy of the common bile duct, the authors list the deformities of the duct associated with pancreatitis. They are classified into 4 stages: (1) lateral displacement of the middle portion of the duct; (2) angulation between the middle and proximal segments; (3) proximal dilatation, with obstructive reflux of contrast medium into the intrahepatic ducts, with eventual formation of calculi; (4) compression of the middle portion. These stages depend upon the extent of pancreatic involvement and the duration of the disease.

While operative cholangiography has been used primarily for the detection of calculi in the biliary system, there have been some reports describing its use in the diagnosis of pancreatitis. The differentiation of inflammation of the head of the pancreas and carcinoma of the head of the pancreas may be difficult even after thorough exploration and palpation. In carcinoma of the head of the pancreas at the stage when it is usually seen, the common duct is occluded, and its proximal portion is markedly dilated, measuring up to 30 mm. In the experience of the authors the maximum dilatation of the proximal common duct in pancreatitis is 25 mm. or

less, and the dilatation of the terminal intrahepatic ducts is never quite as marked as in carcinoma.

It is quite possible that during operative cholangiography, or with the more recent intravenous methods of visualizing the biliary duct system, diagnosis of early cases of carcinoma might be made by demonstrating lateral displacement of the pancreatic portion of the common duct. Usually, however, these patients are admitted to the hospital with obstructive jaundice, and the cholangiograms reveal occlusion of the common duct with marked proximal dilatation.

Eight roentgenograms; 2 drawings.

FRANK T. MORAN, M.D.
Auburn, N. Y.

THE MUSCULOSKELETAL SYSTEM

Non-Osteogenic Fibroma of Bone (Fibrous Metaphyseal Defect). Roy H. Maudsley and Alfred G. Stansfeld. *J. Bone & Joint Surg.* **38-B**: 714-733, August 1956. (Royal Free Hospital, London, England)

So-called non-osteogenic fibroma of bone, first described by Jaffe and Lichtenstein in 1942, presents typical radiographic and pathologic features. It is apparently a distinct entity with a uniformly good prognosis. It is usually found in older children and young adults. Radiographically the lesions appear as sharply defined, radiolucent defects giving the impression of loculation. They are situated near the ends of the long bones of the extremities and are usually eccentric in location, lying close to the cortex and sometimes even within it. At operation a thin-walled cavity is found, often loculated, containing soft or firm rubbery material, of mottled appearance. It is composed of connective tissue of varying cellularity. It tends to be vascular and to contain blood pigment.

The identification of the disease is undoubtedly related to the increased use of radiography in clinically silent cases. The condition, prior to its relatively recent recognition, was likely to be interpreted as one of a number of disease processes, *viz.*, localized osteitis fibrosa, fibrous dysplasia of bone, simple bone cyst, osteoclastoma, solitary xanthoma, fibrous osteomyelitis, or endosteal fibrosarcoma.

Observations on young children indicate that fibrous metaphyseal defects may arise in early life, but heal readily. Cases reported as non-osteogenic fibroma are seen mostly in older children but it seems probable that they are not fundamentally different from the lesions observed in the younger group. Since the non-osteogenic fibroma does not act as a neoplasm it would appear preferable to regard it as a fibrous metaphyseal defect. The development of the defect may be interpreted to be a result of a local vascular disturbance of the growth cartilage. As a consequence of longitudinal growth, it tends to occupy a position away from the epiphyseal plate.

No specific treatment is required if radiographic appearances are sufficiently characteristic to establish the diagnosis and there are no complications. Where the lesion involves the whole width of the bone, or where there is a pathological fracture, exploration and packing with bone chips should expedite healing.

Ten case histories are included.

Twenty-nine roentgenograms; 9 photomicrographs; 2 photographs.

JOHN F. RIESSE, M.D.
Springfield, Ohio

Atypical Reticulum-Cell Sarcoma of the Skeletal System. G. Keiser and H. Hartmann. *Schweiz. med. Wchnschr.* **86**: 911-914, Aug. 11, 1956. (In German) (Kantonsspitals St. Gallen, Switzerland)

Reticulum-cell sarcoma of the skeletal system must be distinguished from the soft-tissue form of reticulum-cell sarcoma as well as from Ewing's sarcoma of bone. The course is often relatively benign, with late metastasis.

The authors describe a case in a 44-year-old woman who died two and a half months following admission to the hospital. Roentgenograms showed multiple sharply contoured osteolytic lesions in the skull, ribs, femora, and scapulae, resembling multiple myeloma, but biopsy, bone marrow aspiration, and eventually autopsy, led to a diagnosis of atypical reticulum-cell sarcoma. Lesions were present in the bone, spleen, liver, kidneys, and lung. Some of the metastases in the kidney and lung contained calcium.

Three roentgenograms; 3 photomicrographs; 1 chart.
JULIUS HEYDEMANN, M.D.
Chicago, Ill.

Blastomycosis of Bone. Report of Four Cases. Peter L. Carnesale and Kenneth F. Stegman. *Ann. Surg.* **144**: 252-257, August 1956. (Veterans Administration Hospital, Wood, Wis.)

The authors present 4 consecutive cases of blastomycosis of bone. Although blastomycotic osteomyelitis occurs rarely, it is one of the commonest fungous diseases of bone. The diagnosis should be considered where cancer or granuloma is suspected. The characteristic roentgenographic appearance is destruction of small circumscribed areas of subepiphyseal or subarticular bone with surrounding mature and homogeneous periosteal bone. In contrast, the edges of a tuberculous lesion are irregular and the adjacent bone is markedly decalcified. When blastomycosis is not accompanied by periosteal reaction, there is a maximum of localized destruction with a minimum of porosis in the neighboring bone. The involved site may resemble an infarct in a long bone. From its subepiphyseal or subarticular location, the fungus may readily spread to involve the adjacent joint. In the spine, destruction of bone is predominant, with little proliferative reaction for relatively long periods. Narrowing of the disk spaces may occur. Spread by skipping from vertebra to vertebra may take place by dissection under the anterior spinal ligament. Associated with this may be a paravertebral fusiform or globular shadow, single or multiple.

The 4 cases reported here were treated by different methods, with arrest of the disease from two to almost seven years. Localized lesions are best treated by surgical procedures. Other methods of therapy, used with variable degrees of success, include irradiation, antibiotics, arsenicals, and copper sulfate. Stilbamidine and 2-hydroxystilbamidine are newer drugs of promise.

Four roentgenograms.

THEODORE E. KEATS, M.D.
University of Missouri

Unusual Osteochondroses Presenting Diagnostic Difficulty. Howard E. Le Bus. *Texas State J. Med.* **52**: 596-598, August 1956. (200 S. Dean St., Glade-water, Texas)

Two cases are presented as "osteochondroses" although biopsy in each showed normal tissue. The

first case was typical of asymmetrical fusion of the ischio-pubic synchondrosis shown by Caffey (Am. J. Roentgenol. 76: 488, 1956) to be nothing more than normal variation. The second involved the ischial tuberosity and appeared to represent delay in ossification of the apophysis of the tuberosity on one side, but there was no roentgen follow-up. Perusal of the article with the thought in mind that the condition might be a normal variant convinces one that this is so. The symptoms are vague and of short duration; no treatment is necessary and no deformity results. The negative biopsies provide the final proof.

Three roentgenograms (poorly reproduced).

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Radiologic and Pathologic Bone Changes Associated with Urticaria Pigmentosa. Report of a Case. Ernest Stark, Frederick W. Van Buskirk, and John F. Daly. Arch. Path. 62: 143-148, August 1956. (University of Vermont College of Medicine, Burlington, Vt.)

Urticaria pigmentosa is primarily a skin affection, but may be systemic and involve other structures. A case is described which showed widespread bone involvement, and in which it was possible to obtain rib biopsy for histologic study.

The patient, aged 54, had a widespread, diffuse, maculopapular skin eruption of many years duration. Dermatologic diagnosis was urticaria pigmentosa of adult type. The long bones showed roentgenologic evidence of thickening of trabeculae and widening of the intervening interspaces. In the vertebrae the trabeculae were more compactly arranged, so that the overall effect was an increase in density. In the ribs there were multiple small, punched-out areas of rarefaction. The skull, hands, and feet showed no radiographic changes.

Histologically, the lesions were distinctly granulomatous, and were made up principally of mast cells. Although similar x-ray findings have been described in the past, histologic studies on the bone lesions have not been previously reported.

Eleven figures, including 5 roentgenograms.

DON E. MATTHIASEN, M.D.
Phoenix, Ariz.

Paralytic Scoliosis. Robert Roaf. J. Bone & Joint Surg. 38-B: 640-659, August 1956. (Oswestry, England)

The term "paralytic scoliosis" as used here is limited to scoliosis occurring in patients who have had a definite attack of poliomyelitis.

In the adult spine fairly extensive paralysis can occur with only slight deformity, but in the child the bones are soft and plastic, ligaments are elastic, and the intervertebral disks are less rigid. Therefore, the younger the patient the greater the deformity that a given degree of muscle paralysis is likely to produce.

Paralytic scoliosis is associated with two main disabilities. The first is that due to the deformity of the spine and associated deformities of the thoracic and abdominal walls and their contents. The second is spinal instability. The two aspects—deformity and instability—do not necessarily run parallel, but to carry out proper treatment both must be considered in every case.

The author recognizes four main types of deformity.

1. The general thoracolumbar C-curve. This

usually occurs in patients who have had only slight paralysis. There is slight rotation deformity, more pronounced on standing than in recumbency.

2. General "collapse" type of combined thoracic and lumbar curve, due to extensive spinal weakness. There is moderate rotation deformity and curves are mobile for some time.

3. The primary lumbar curve, due to a combination of pelvic obliquity and imbalance of trunk muscles. There is usually a compensatory curve of lesser degree.

4. Primary thoracic curve, often associated with weakness of the scapular muscles. There are usually secondary compensatory curves above and below.

Among factors that have been suggested as being responsible for deformity in paralytic scoliosis are pelvic obliquity, imbalance of abdominal, psoas, quadratus lumborum, diaphragm, intercostal, rhomboid, trapezius, latissimus dorsi and deep and superficial spinal muscles. None of these singly explains satisfactorily the deformities seen. At least five factors seem to be involved: (1) compensation; (2) imbalance of the extraspinal muscles; (3) primary disturbance of vertebral growth; (4) imbalance of the deep spinal rotator muscles; (5) fascial contracture.

Prevention of scoliosis following poliomyelitis requires intelligent application of rest, active or passive movements, splinting, and prophylactic operations. Active treatment of deformities is outlined in some detail. The author recalls the platitude that in poliomyelitis one treats the individual and not the disease—easily said but often forgotten.

Eighteen roentgenograms; 8 photographs; 2 diagrams.

JOHN F. RIESSER, M.D.
Springfield, Ohio

Paralytic Scoliosis. J. I. P. James. J. Bone & Joint Surg. 38-B: 660-685, August 1956. (Royal National Orthopaedic Hospital, London, England)

In a study of a series of 193 patients with paralytic scoliosis, seen after poliomyelitis, an attempt was made to classify the deformities on the basis of anatomical site, to discover the prognosis, and to correlate the associated muscle paralysis with each group. A parallel series of 280 patients with poliomyelitis but without scoliosis was studied and it was found that children with an average of seven years from the onset of the disease showed frequent asymmetrical paralysis of limb muscles but no curvature of the spine.

In idiopathic scoliosis 2 groupings based on the anatomical site of the primary curve appear rather clear-cut and the site of the curve has a definite prognostic import. Classification of paralytic scolioses by anatomical site is not so clear-cut, and prognosis was found to depend more on degree of muscle imbalance and age of onset of the paralysis than on the anatomical level.

In the group of 193 patients, curve patterns were distributed as follows:

High thoracic.....	39
Thoracic.....	69
Thoracolumbar.....	47
Lumbar.....	17
Combined thoracic and lumbar.....	13
"Telescopic" spine.....	8

In the high thoracic group, paralysis of arm muscles was not felt to be significant. The intercostals on the

convex side of the curve are believed to be the only muscles significantly paralyzed.

Paralysis of the intercostals is also the dominant cause of the *thoracic deformities*, where the upper limit of the primary curve is at the level of the third thoracic vertebra or lower. The anterior abdominal muscles and the lateral abdominal flexors play a part. In paralytic scoliosis, films show a rib "droop" and rib crowding on the convex side of the thoracic curve which is opposite to the appearance in idiopathic scoliosis, where the ribs on the convex side are spread while those on the concave side are crowded. Cineradiography was employed to show diminished rib movement on the side of intercostal paralysis.

In the *thoracolumbar group*, the apex of the curve is at the level of T-11 or 12. The noteworthy feature was weakness of lateral abdominal flexors on the convexity. Some basal weakness of intercostals was occasionally encountered.

The *lumbar group* was fewer in number. The apex of the curve was always in the lumbar vertebrae. The important muscles involved were the lateral abdominal flexors—the quadratus lumborum, lateral portion of the anterior abdominal muscles, and latissimus dorsi. Associated with imbalance of lateral flexors is a pelvic tilt.

There is a group of *combined thoracic and lumbar scoliosis* which should be noted, since fusion of only one primary curve may be followed by increase in the second primary curve, with disastrous results.

The so-called *telescopic spine* represents the combined effect of weakness of trunk muscles and the pull of gravity so that there is a considerable difference in the erect and supine curve measurements.

Structural lateral deformity was not seen in any girl in whom poliomyelitis developed after the age of fourteen, or in any boy after fifteen. In 34 adults followed for several years after appropriate muscle paralysis, scoliosis failed to develop.

Illustrative case histories are included.

Thirteen roentgenograms; 18 photographs; 7 graphs.

JOHN F. RIESSER, M.D.
Springfield, Ohio

The Importance of Myelography in Spinal Pathology. Analytical Study of 150 Cases. F. J. Borrelli and A. A. Maglione. *Am. J. Roentgenol.* 76: 273-289, August 1956. (New York Medical College, Flower and Fifth Avenue Hospitals, New York, N. Y.)

After a review of the history of myelography and a description of the important anatomical features, the authors' technic is described. For examination of the lumbar region 3 c.c. of contrast material is generally sufficient. For cervical myelography 6 or 9 c.c. is recommended. It has been found that a more leisurely and safer positioning of the contrast material in the cervical region can be effected by having the patient lie on his side while his head is lowered to allow the oily substance to gravitate into the cervical spinal canal. An easier control of the contrast material is accomplished, with less likelihood of its spilling over into the cerebrospinal fluid pathways of the cranium. Following completion of myelography an effort is made to remove completely the contrast medium, because of its apparent irritative effects in a small percentage of patients. A series of 150 of the authors' personal cases is analyzed.

Types of filling defects associated with spinal cord

tumors and a classification of such tumors is outlined in detail. Some of these defects may be fairly characteristic of a tumor; some may be produced also by other conditions.

Various types of defects occurring with herniation of the intervertebral disk are considered next. A *uni-lateral anterolateral filling defect* was the most frequent deformity, encountered in 38 per cent of the cases reported here. *Bilateral hour-glass deformity* was demonstrated in 13 per cent and is felt to be best accounted for by a mid-line protrusion displacing the components of the spinal cord into two portions with a central narrowed channel between. *Block or complete obstruction* was found in only 8 per cent of the cases and usually resulted from mid-line prolapse. *Anterior indentation of the opaque column*, as shown by films made with a horizontal x-ray beam and the patient prone, was observed in 30 per cent of the cases. In 9 instances (6 per cent) this was the only positive myelographic finding. The authors feel that this "transvertebral" horizontal beam view is an extremely valuable one and should be used in all myelographic studies. A slight indentation along the anterior margin of the oil column at the exact level of the disk space is normal and is ascribed to closely adjacent ligaments surrounding the disk. Any indentation greater than 2 mm. is believed to be pathological. The "veil defect" was rarely encountered and was explained by a thin layer of contrast material partly covering a central herniation. *Nerve root sheath amputation or asymmetry* was also rare in this series of 150 cases. It is probably due to lateral protrusion of the disk, with impingement on the nerve root, without deformity of the main oil column.

Causes of errors in myelography are analyzed. In addition to the well known needle defects, improper contrast material injections, postoperative adhesions, and residuals from previous punctures, the authors comment at some length on changes associated with hypertrophic spondylo-arthrotic changes. They feel that myelography in patients with prominent hypertrophic spurrings is frequently not helpful and may be frankly misleading. The spurrings may produce deformities of the oil column indistinguishable from herniated disks or even tumors.

In this series a high overall percentage (85 per cent) of accuracy was attained as judged by operative findings.

Twenty roentgenograms; 1 table.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Myelography of Complete Spinal Obstruction. Arthur S. Tucker. *Am. J. Roentgenol.* 76: 248-269, August 1956. (Department of Radiology, University Hospitals, Cleveland, Ohio)

Among 196 consecutive myelograms, complete obstruction of the spinal canal was encountered in 75 (in 73 patients). In general, myelography was performed only on patients whose clinical findings were not clear-cut and in whom a sharp localization of the lesion was not obtainable by other methods.

The 75 instances of spinal block are individually analyzed and grouped as to etiology. Neurofibroma (neurilemmoma) accounted for 15 cases (20 per cent), with involvement of the thoracic portion of the spine in 10 and the lumbar spine in 5. It was usually possible to determine from the appearance of the contrast column whether the tumor was intradural or extradural: a

concave form of the end of the column is almost certainly associated with intradural neoplasm; extradural lesions usually result in an eccentric, funnel-shaped narrowing of the channel.

Twelve cases were due to intervertebral disk protrusion. Two of these cases were of additional interest in that the disk material had gained access to the subdural space through a rent in the bound-down dura overlying the annulus. Findings in such instances closely mimicked intradural spinal cord tumors.

Meningiomata accounted for 11 of the blocks and ordinarily produced typical intradural defects. The most common localization was the thoracic spine.

In 6 cases there were partial or complete blocks referable to arachnoiditis or adhesions. These usually presented a rather characteristic broken-up oil column with separate globules at different levels, associated with slowly moving, irregularly flowing contrast medium.

Various malignant tumors of metastatic or multiple nature accounted for 20 per cent of the spinal blocks, all extradural. Infectious processes, congenital anomalies, or less common neoplasms were responsible for the remainder of the reported obstructions. In this series the intramedullary causes of obstruction were almost insignificant as compared to the extramedullary causes. Only 3 blocks from intramedullary lesions were found.

The author ascribes the high percentage (39 per cent) of cases showing more or less complete block to the fact that his group reserves myelography as a "court of last appeal," utilizing the procedure only when other simpler methods of diagnosis have failed to give sufficient information or localization.

[Many of the author's numerous roentgenograms fail to show very conclusively the points under discussion. The roentgenographic reproductions are rather small and not always of good detail.—J. W. B.]

Fifty-two roentgenograms; 2 drawings; 1 table.

JAMES W. BARBER, M.D.

Cheyenne, Wyo.

The Roentgen Diagnosis of Herniated Disk with Particular Reference to Diskography (Nucleography).

William G. Peacher and Richard P. Storrs. *Am. J. Roentgenol.* 76: 290-302, August 1956. (W. G. P., 713 E. Genesee St., Syracuse, N. Y.)

The authors first review the advantages, disadvantages, and limitations of myelography in the study of low back pain. It is preferred to initiate the investigation with that procedure rather than discography, as the former will give a definitive answer in over 90 per cent of the cases. Discography (nucleography) generally should be reserved for patients with negative or equivocal myelograms, in whom atypical clinical or neurological signs are otherwise unsatisfactorily explained. The procedure may be helpful also in study of postoperative recurrent symptoms and in patients recalcitrant to therapy.

Some of the advantages of discography include rapid, complete absorbability of the contrast material (Diodrast), without need for its removal; sharp localization of the pathological process with a high degree of accuracy; and accurate demonstration of the exact status of the disk anatomy, particularly with respect to partial herniations or degeneration without herniation. Limitations generally are that only the lower 3 or 4 lumbar disks can be easily studied; that the tech-

nical features of a satisfactory examination are somewhat complicated and the procedure is time-consuming; that in some cases absorption or disappearance of the contrast material is so rapid that diagnostic films are not obtained.

The authors have modified previously published technics to some degree. They prefer a single 20 or 22 gauge long spinal needle rather than the double needle method. The needle point is adjusted to the center of the punctured disk. Lateral views are obtained with the spine in flexion and in extension, followed by a lateral upright view with the spine in neutral position. These views allow a study of the disk in various simulated conditions of normal stress and strain. The greatest herniation was usually shown when the patient was erect.

Diagnostic points include the degree of pressure necessary to inject the Diodrast, the amount of contrast material injected, and the presence or absence of symptoms produced by the injection. The normal disk will ordinarily accept 0.5 to 1.0 c.c. under high pressure. Degenerated disks will accept 3 to 5 c.c. and the injection will characteristically reproduce the patient's pain. Ruptured disks, because of escape of contrast material into the epidural or subdural space, will accept an unlimited amount of contrast agent usually under low pressure. Pain may or may not be produced by the injection, but no more than 5 c.c. should be used. With herniation, the bulk of the contrast material is present in the extradural space. Degenerated disks without herniation usually present a diffuse, disorganized appearance. When the disk begins to protrude, contrast material can be seen bulging into the spinal canal but remains localized. In actual disk herniations, the presence of associated tissue particles or debris at the point of escape is an important diagnostic finding and will rule out escape of contrast material along the needle tract.

The authors present several roentgenograms of their own patients but fail to state how many such studies the present paper includes.

Fifteen roentgenograms. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Natural History of Osteoid Osteoma of the Spine. Review of the Literature and Report of Three Cases.

Alvina O. Sabanas, William H. Bickel, and John H. Moe. *Am. J. Surg.* 91: 880-889, June 1956. (A. O. S., Mayo Clinic, Rochester, Minn.)

Three cases of osteoid osteoma of the spine, in patients of nine to eleven years when first seen, followed without definitive surgery, are reported. The chief clinical findings were back pain and scoliosis. Diagnosis was based not on biopsy but on the course and x-ray appearance. Two cases treated with a body cast and postural exercises resolved in eight and six years, respectively, with residual increased density of bone and hypertrophic changes of the vertebral bodies in the affected region. In the third case, symptoms ended after four years, but moderate scoliosis persisted.

Data on 33 additional cases of osteoid osteoma of the spine found in the literature were analyzed. Twenty-seven of these were proved microscopically, and the symptoms were relieved after surgery. The age at onset of symptoms was three to twenty-seven years, over half the patients being between eleven and twenty years.

The clinical and roentgen findings are analyzed on

the basis of the entire series of 36 cases. A C-shaped scoliosis curve with the apex at the level of the lesion was practically always present. Roentgenograms in 13 cases showed a radiolucent area, with or without adjacent sclerosis (usually not prominent). In 6 cases a radiopaque nidus was demonstrated, surrounded by a radiolucent ring, with or without sclerosis beyond the ring. In 6 cases, with a duration of more than two years, there were hypertrophic changes adjacent to the lesion. In 3 cases, the roentgenogram was normal.

In every case of scoliosis with a long C-shaped curve, accompanied by spasm and localized tenderness, osteoid osteoma should be considered. Tomography and repeated roentgenograms at three-month intervals may be helpful.

Nine roentgenograms; 1 drawing; 3 tables.

CAPT. GARTH R. DREWRY
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Prognosis and Early Diagnosis of Nonunion of Femoral Neck Fractures by Laminography. Norman Rosenberg, Rudolph Reich, and Melvin Krohn. *Arch. Surg.* 73: 157-163, July 1956. (Mount Sinai Hospital of Cleveland, Cleveland, Ohio)

In metallic fixation of fractures of the femoral neck, union occurs in 80 to 90 per cent of the cases. In the group in which union does not occur the situation is frequently discovered early in the postoperative period by complete dissociation of the fragments, which can be recognized clinically and confirmed by standard roentgenograms. In another smaller number, the lack of union may not be appreciated for a matter of months. The authors are concerned with this group, for if the non-union is diagnosed early and treated, there is a better chance for a successful outcome.

Laminagrams are not of any particular value in demonstrating bone healing, since the healing in the femoral neck is largely endosteal and no periosteal callus is produced. Their value lies in determining the degree of apposition of the fragments, which, if the nail has been well placed, is the prime requisite for healing. It is uncommon to find 100 per cent apposition, and most cases which appeared excellent on conventional films showed only 60 to 70 per cent apposition on the laminagram. This, however, is entirely satisfactory for healing, which many times will occur with only 50 per cent apposition.

By study of the degree of apposition on the laminagrams it is usually possible to determine early which cases will heal and in which non-union may develop, making earlier intervention possible.

Forty-five roentgenograms.

DEAN W. GEHEBER, M.D.
Baton Rouge, La.

THE SPINAL CORD

Measurement of the Cervical Spinal Cord in Pantopaque Myelography. Edward C. Porter. *Am. J. Roentgenol.* 76: 270-272, August 1956. (Eastern Maine General Hospital, Bangor, Me.)

The transverse width of the normal spinal cord was measured at the C-4 or C-6 level in 65 patients with presumably normal cords. The cervical subarachnoid space was filled with Pantopaque and fluoroscopic spot films were obtained at an average anode-to-spine distance of 23 inches and average spine-to-film distance of 10 inches. The central lucent shadow of the cord in

the oil column was then measured directly on film, with care to measure only the inner shadow of the true cord rather than the entire central shadow, which includes the nerve roots. It is evident that such a technic involves considerable magnification distortion but no effort was made to correct for this.

With such a technic, the average width of the cervical cord in normal cases was 1.4 cm. as measured on the film, with a maximum normal of 1.7 cm. Any measurements above 1.8 cm. should be viewed with suspicion, while a transverse diameter above 2.0 cm. is definitely abnormal. Two cases with medullary cord tumors showed transverse diameters well above this normal level.

Two roentgenograms. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

GYNECOLOGY AND OBSTETRICS

Atresia of the Vagina in Infancy. Robert H. Whitteley, Mohammad Atik, and James C. Jones. *Pediatrics* 18: 260-266, August 1956. (R. H. W., 11311 Shaker Blvd., Cleveland 4, Ohio)

The differential diagnosis of a lower abdominal mass in the newborn female infant should include hydrocolpos, though this condition is more common at puberty, when the products of menstruation become dammed behind an imperforate hymen. When a bulging membrane is not visualized between the labia of an infant, the possibility of hydrocolpos may be dismissed without due consideration of the possibility of an atresia somewhat higher in the vagina. Such atresias do occur and are attributed to failure during fetal development of the fused lower ends of the müllerian ducts to perforate the urogenital sinus, the latter contributing the lower one-third of the fully developed vagina. The resulting septum varies in thickness from 1 to several millimeters and forms a diaphragm at the junction of the middle with the lower third of the vagina.

The soft-tissue abdominal mass rising out of the pelvis is the result of retained secretions from the vaginal and uterine mucosa, which are under stimulation by the maternal estrogens during fetal life. The tumor may at first be asymptomatic but after some days vomiting, irregular bowel habits, and intermittent urinary obstruction may supervene. The symptoms are largely due to pressure on the neighboring organs by the mass.

Plain films of the abdomen reveal the upward and lateral displacement of the gas-filled loops of bowel, which can be further verified with a contrast enema. Cystograms demonstrate distention due to bladder neck obstruction caused by the mass, as well as displacement of the viscus. Excretory urograms will confirm the obstruction and show varying degrees of ureteral displacement and hydronephrosis. Should these studies, plus rectal examination, fail to establish the diagnosis, the authors recommend pneumoperitoneum, which they believe to be innocuous, to further delineate the mass on films made in the recumbent, upright, inverted, and lateral decubitus positions.

Although treatment may consist simply of colpotomy from below, the authors advocate laparotomy to confirm the diagnosis, prevent the hazard of injury to surrounding structures, and establish vaginal continuity without the danger of recurrence of the atresia.

Eight roentgenograms; 3 drawings.

SAUL SCHEFF, M.D.
Boston, Mass.

THE GENITOURINARY SYSTEM

"Spongy" Kidney and Nephrocalcinosis. G. Bales-tra and B. Delpino. *Radiol. med.* 42: 745-764, August 1956. (In Italian) (Istituto di Radiologia dell' Università di Genova, Genoa, Italy)

The term "spongy" kidney describes a microcystic alteration of the renal pyramids, with subsequent formation of calculi within the cysts (*i.e.*, intraparenchymatous calculosis). While inflammatory, mechanical, and neoplastic theories have been advanced to account for this condition, a dysembryogenesis of the prepelvic excretory channels is the most widely accepted explanation. The symptomatology is non-specific, and usually secondary to the elimination of calculi. Sometimes there is associated decrease in kidney function and/or systemic arterial hypertension. The majority of patients are males in the thirty- to fifty-year age group.

The disease affects neither the elimination nor the concentration of urographic contrast media in the blood stream. On the roentgenograms, a number of parenchymal cavities, distributed along the calyces in the shape of a "bouquet of flowers," can be seen. These cavities do not extend to the cortex, and a calyceal origin can be easily ruled out, as the anatomical location is obviously within the pyramids. In some advanced cases, the cortical tissue is thinned, and the spaces between the pyramids are widened, resulting in the porous appearance which prompted the use of the term "spongy." Intraparenchymal calculi are often present on one or both sides, usually multiple, but occasionally solitary. The stones, well seen on conventional views, are of various sizes up to 1 cm. in diameter. The condition is seldom progressive; yet at times several cysts may unite to form a larger one. Unless the papillary sphincter is damaged, the retrograde examination is negative.

"Spongy" kidney must be differentiated from (1) tuberculosis cavities, which are seldom symmetrical, often subject to changes as the disease progresses, and usually associated with a delay in the excretion of contrast medium; (2) parenchymal nephrolithiasis (circumscribed and localized); (3) small pyonephritic abscesses that communicate with the pelvis of the kidney and are better seen on retrograde urography; (4) necrotizing papillitis involving the apex of the pyramid. In the last named, there is also a history of diabetes, and the distribution is different.

The term "nephrocalcinosis" defines the presence of bilateral, diffuse renal calcifications, generally localized in the pyramids. The first calcium deposits appear in the basal membrane of the walls of the collecting tubules, with subsequent deformity and obstruction, and finally deposition of calcium in the adjacent interstitial spaces. There are various degrees, the amount of destruction and calcification being influenced by concomitant infectious and/or inflammatory processes. Nephrocalcinosis, which is not a disease in itself, may appear as a result of many conditions: (1) hyperparathyroidism, (2) hyperchloremic acidosis, (3) chronic inflammatory processes, (4) idiopathic hypercalcinuria and nephrolithiasis, (5) prolonged intake of alkalizers, (6) dehydration from repeated emesis during incomplete obstruction of the upper gastrointestinal tract, (7) hypervitaminosis D, (8) mercury poisoning, and (9) extensive osteolytic activity (multiple myeloma, bone metastases). The symptomatology up to a cer-

tain point is unrelated to the amount of calcification (which presumably does not interfere with kidney function). There is no age limitation, and both sexes are affected, although the condition is somewhat more frequent in the male.

Nephrocalcinosis can be adequately studied on routine views. Its roentgenologic appearance is most often that of small clusters of calcium in the parenchyma more numerous and better seen toward the calyceal apices; less often, that of multiple renal lithiasis, and very rarely a uniform increase in density of the entire kidney without the usual granular aspect.

Nephrocalcinosis can be seen on the "scout" roentgenogram, while the "spongy" kidney, in the absence of calculosis, requires an excretory urogram for demonstration. Moreover, the "spongy" kidney is unilateral, while nephrocalcinosis is usually bilateral. On the other hand, cystic changes are known to occur in nephrocalcinosis. In conclusion, the authors would reserve the use of the term "spongy" kidney for unilateral disease with a positive excretory urogram, applying the more non-committal "nephrocalcinosis" to doubtful cases, allowing, of course, for ulterior etiologic investigations.

Thirteen roentgenograms. E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

Arteriovenous Fistula of the Renal Vessels. A Case Report. Jon R. Myhre. *Circulation* 14: 185-187, August 1956. (Department of Medicine, University Clinic, Bergen, Norway)

Massive hematuria in a woman of 66 led to pyelographic and aortographic studies, showing an expanding process in the right kidney and arteriovenous communication in the abnormal area. Since some additional arteriovenous fistulae were seen in the liver, no surgery was done at that time (the bleeding stopped in a few days). Six months later the bleeding recurred and nephrectomy was performed. An adenocarcinoma was found, partially surrounding the hilar vessels and causing the fistula by erosion. Since no congenital abnormalities were found in the vessels, the hepatic changes were considered to be merely coincidence.

[It is interesting to note that, had the authors been content with the really very conclusive evidence of a tumor on the pyelograms, nephrectomy would have been done six months earlier. The aortogram served only as a red herring.—Z. F. E.]

Two roentgenograms. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

A Clinical Study of a New Renal Function Test: The Radioactive Diodrast Renogram. Chester C. Winter. *J. Urol.* 76: 182-196, August 1956. (Department of Surgery, Veterans Administration Medical Center, Los Angeles, Calif.)

A new radioactive isotope tracer technic is described in this article for the estimation of renal function. Essentially the test consists of scintillation counter measurements of the rate of uptake and disappearance of Diodrast tagged with 131 from the kidney areas following intravenous injection. The rate meters are connected to recorders which produce tracings in each case.

Testing was carried out on 216 cases in this series, which included a wide variety of urologic disorders, and characteristic renogram patterns were obtained and classified.

It appears that the test could become a useful quick screening test for kidney function. It requires only ten to thirty minutes, is less complicated to perform than the various renal clearance tests, requires no preliminary patient preparation, and permits testing of function of each kidney separately. However, it does require the handling and injection of a radioactive isotope, the initial equipment is expensive, and improper placement of the scintillation counters relative to the kidneys may lead to errors of interpretation. For example: in testing the right kidney, interference from the liver may be a major source of confusion.

The method has so far proved useful for studying non-functioning (or absent) kidneys, complete ureteral obstruction, partial ureteral obstruction and hydronephrosis, chronic nephritis, acute pyelonephritis, and nephrosclerosis, and for serial evaluation of renal function.

Ten illustrations; 1 table.

DON E. MATTHIEN, M.D.
Phoenix, Ariz.

Sodium Amidotrizoate (Hypaque) and Sodium Acetrizoate (Urokon). Comparison of Efficacy in Intravenous Urography. Malcolm D. Jones, Howard L. Steinbach, and Robert L. Raphael. *Arch. Surg.* **73**: 99-104, July 1956. (Department of Radiology, University of California School of Medicine, San Francisco, Calif.)

A comparative study was made of 50 per cent Hypaque and 50 per cent and 30 per cent Urokon. The roentgenograms made after the administration of the media were graded as to calyceal demonstration, pelvic demonstration (including density), and percentage of ureteral visualization. The frequency and types of reactions were considered, and their relation to blood pressure changes was noted. Hypaque was used in 109 persons, Urokon 50 per cent in 114, and Urokon 30 per cent in 54.

Hypaque in 50 per cent concentration produced consistently better urograms than Urokon in 30 per cent concentration. It was also found that, with similar concentrations, only half as many reactions occurred with Hypaque as with Urokon. Reactions were more commonly observed in patients showing a hypotensive response to Hypaque than in those whose blood pressure increased or remained unchanged.

Hypaque in the concentration used resulted in roentgenograms with superior pelvic and calyceal density as well as superior visualization of the ureters.

Two roentgenograms; 4 charts; 1 table.

DEAN W. GEHEBER, M.D.
Baton Rouge, La.

Urologic Examination with the New Radiopaque Media, Diatrizoate, Acetrizoate, and Diprotrizoate. A Clinical Comparison. Howard A. Hoffman, Stanley J. Koczera, Nelson L. Portnoy, Wilson Simas, and Alois R. Hastreiter. *New England J. Med.* **255**: 343-345, Aug. 16, 1956. (H. A. H., 60 Eighth St., New Bedford, Mass.)

Comparative urologic examinations carried out in small groups of patients with the new radiopaque substances, sodium diatrizoate (Hypaque) acetrizoate (Urokon), and diprotrizoate (Miokon) showed all three to be highly efficient intravenous contrast media for delineation of the urinary tract. Excretory pyelograms were obtained with diatrizoate in 50 patients, with acetrizoate in 42, and with diprotrizoate in 20. In

addition to the intravenous studies, retrograde examinations with 50 per cent diatrizoate were carried out in a group of 30 patients; excellent visualization was obtained in 8 cases, good visualization in 14, fair visualization in 7, and poor visualization in 1. It is concluded that diatrizoate is the most suitable of the three agents; its advantage over other available contrast substances for intravenous administration is the relative safety with which it may be used, as evidenced by the fewer and less severe untoward reactions occurring during the present study. When intravenous techniques are contraindicated, diatrizoate is an efficient medium for retrograde pyelography.

Four tables.

Hypaque Sodium, a New Urographic Contrast Medium. Tom E. Nesbitt, N. W. Bourne, and D. P. Babbitt. *Wisconsin M. J.* **55**: 815-819, August 1956. (T. E. N., 208 East Wisconsin Ave., Milwaukee, Wis.)

Hypaque Sodium was used in 537 patients for excretory pyelography and in over 100 patients for retrograde urography. In the intravenous form, it was supplied as a 50 per cent solution in 30 ml. quantities. Approximately 90 per cent of the films obtained were satisfactory for diagnosis, being termed either excellent or of good quality. Those patients in whom the results were only fair or poor in quality (10 per cent of the total) were found, almost without exception, to have some form of renal or vascular disease accounting for the diminished excretion.

Objectionable reactions were encountered in 6.3 per cent of the patients, none of whom, however, required supportive measures.

Retrograde urography with a 20 per cent solution of Hypaque resulted in x-rays of optimum density and no adverse reactions.

The probable method of Hypaque excretion is presented to emphasize the role of glomerular filtration and the importance of adequate dehydration.

Five roentgenograms.

Major Reactions to Intravenous Urographic Media. Charles H. Nicolai. *Arch. Surg.* **73**: 285-289, August 1956. (Department of Surgery, Washington University School of Medicine, St. Louis, Mo.)

This is a review of the subject of major reactions to intravenous urographic media. Six serious reactions (2 fatal) to Urokon injections, which occurred during a series of 12,000 urograms, are reported.

The pathogenesis of the reactions, both minor and major, has not yet been worked out but, for the present, allergic response forms a satisfactory working basis in management. Intravenous test doses prior to the full injections have been of doubtful value; they did not elicit any reactions in the cases of this series. Slow, cautious administration of the medium has apparently lowered the incidence of reactions. Reports on the usefulness of antihistaminics as a protective measure are conflicting.

In 5 of the author's 6 cases 70 per cent Urokon was used. In the remaining case a cyanotic, comatose state followed injection of 25 c.c. of 50 per cent Urokon.

Whenever intravenous urograms are to be done, it is important that there be available equipment for oxygen administration and for emergency thoracotomy, along with the usual vasopressor and parenteral antihistamine preparations.

DON E. MATTHIEN, M.D.
Phoenix, Ariz.

Iodide "Mumps" after Intravenous Urography. Ralph M. Sussman and Jay Miller. *New England J. Med.* 255: 433-434, Aug. 30, 1956. (Beth Israel Hospital, New York, N. Y.)

Salivary gland swelling as a manifestation of iodide idiosyncrasy after intravenous injection of contrast organic iodides is a rarity. The authors described 2 cases. Submaxillary gland swelling occurred in a 62-year-old male forty-eight hours after intravenous urography with 20 ml. Renografin (sod. methylglucamine diacetylaminotriiodobenzoate). Six days prior to this examination, he had received organic iodide orally for cholecystography. In the second patient tumefaction of the parotids developed two days after a 30-ml. dose of Hypaque (sodium diatrizoate) intravenously. In this instance there was no mention of prior administration of organic iodide. In both cases epidemic parotitis and salivary-gland calculus could be excluded by examination, history, and roentgenographic study. In each the condition disappeared spontaneously within a week.

It is pointed out that recent exposure to organic iodides during contrast visualization should be a consideration in the differential diagnosis of parotid or submaxillary adenitis in adults. It is further suggested that in the course of a general work-up, where multiple contrast visualization with organic iodides is contemplated, the use of the intravenous technic initially would tend to avoid the subsequent dangerous anaphylactoid reactions which are more likely to follow intravenous injection.

In an editorial comment on this paper, further attention is called to the potential dangers of iodine-containing compounds as used for diagnostic purposes, especially in the presence of renal impairment.

SAUL SCHEFF, M.D.
Boston, Mass.

THE ADRENALS

Roentgenological Appearance of Normal Adrenal Glands. Richard H. Harrison, III, and Leonard C. Doubleday. *J. Urol.* 76: 16-22, July 1956. (R. H. H., 109 Porter Bldg., Bryan, Texas)

Presacral retroperitoneal air studies were performed on 50 patients with non-endocrine disorders, using an average of 1,000 c.c. of room air per 65-kg. individual. In 31 cases at least one adrenal was visualized. In 13, both adrenals were adequately visualized for measurement. The best films were usually obtained twenty-four hours after injection. All of the subjects complained of lower abdominal fullness, but no serious complications were encountered.

On the basis of their observations, the authors present an average set of dimensions. A line connecting the points of the base of the adrenal was considered the "base measurement." The distance from the apex of the gland to its lower edge along a line bisecting the base line was considered "height measurement." On anteroposterior supine films at 36-inch target-film distance, the results were as follows: right adrenal, base 1.0 to 3.3 cm., height 1.4 to 4.0 cm., area 1.0 to 4.0 sq. cm.; left adrenal, base 2.4 to 5.0 cm., height 1.5 to 3.5 cm., area 1.4 to 8.2 sq. cm. Both adrenals were usually roughly triangular in shape, although textbooks frequently describe the left adrenal as crescent-shaped. In 2 cases the right adrenal appeared as a thin-wedged, elongated shadow.

The fundus of the stomach, tail of the pancreas, and left lobe of the liver may simulate an adrenal mass.

Three roentgenograms; 1 photograph; 2 drawings; 1 table.

CAPT. GARTH R. DREWRY
U.S.A.F. Hospital, Tampa, Fla.

MISCELLANEOUS

Radiological Diagnosis of Hydatidosis. Francisco P. Cifarelli. *Acta radiol. interam.* 5: 17-27, October-December 1955. (In Spanish) (Tucumán 1341, Rosario, Argentina)

The relative frequency of occurrence of hydatid disease in various organs is given by the authors as follows: liver 70 per cent, lungs 15 per cent, muscles 4 per cent, bones 2 per cent, nervous system, 2 per cent, brain 2 per cent, kidneys 2 per cent. Eighty-five per cent of the cases involve regions where venous blood abounds, and 15 per cent where arterial blood predominates. Calcification is an important aid in the radiologic diagnosis.

The radiologic signs in different localizations are as follows:

Liver: Calcification of the cyst wall, which may be partial or complete.

Lungs: Well circumscribed shadows in the lung field with a radiolucent central zone. These may be single or multiple, simple or complicated. Calcification is exceptional.

Spleen: Large, spherical single shadows; a tendency to displacement of neighboring organs.

Kidneys: A characteristic calcified circular outline, with a tendency to displacement of the calyceal system.

Peritoneal cavity: The presence of a cyst in the peritoneal cavity indicates rupture of a hepatic cyst. The characteristic sign is displacement and extrinsic pressure on hollow viscera.

Bones: Multilocular osteolytic images without cortical reaction, most commonly in the pelvis and spine.

Brain: Calcification in the cyst wall. Deformities of the central cavities may be observed on pneumo-ventriculography. Arteriography is also applicable.

Eighteen roentgenograms; 9 drawings.

JOSEFA DEL CARMEN, M.D.
St. Vincent's Hospital, New York

Roentgenographically Demonstrable Splenic Deposits in Sickle Cell Anemia. George Jacobson and Sidney D. Zucherman. *Am. J. Roentgenol.* 76: 47-52, July 1956. (Department of Radiology, Los Angeles County Hospital, Los Angeles 33, Calif.)

Although the occurrence of iron and calcium deposits in the spleen of patients with sickle-cell anemia has been described pathologically on numerous occasions, it has seldom been emphasized as an important finding on roentgenograms of the abdomen.

The authors reviewed 106 proved cases of sickle-cell disease in which roentgenograms of the abdomen were available. In 4 cases and a questionable fifth, visible deposits were found in the spleen. All 4 patients were females, but while the disease occurs almost as frequently in women as in men the series is too small to permit any reliable conclusion as to a possible sex predilection.

In sickle-cell disease the spleen becomes enlarged and soft, with intense congestion of the pulp with sickle-shaped red blood cells. Hemorrhages occur in the region of the terminal arterioles followed by organization, thickening of the vessel walls, pigmentary changes,

and deposition of mineral salts. Infarcts are common. The spleen gradually becomes smaller, with organization of the hemorrhagic areas to form small nodules in the connective tissue, containing calcium and iron pigment. These gradually become dense and hyalinize. In the later stages the spleen contracts to a small, hard, nodular fibrotic organ.

The calcium and iron deposits are demonstrable roentgenographically as closely packed nodular densities, usually rounded and discrete. As the spleen contracts, the deposits become irregular and confluent. This appearance is fairly characteristic of sickle-cell anemia.

Five roentgenograms. FRANK T. MORAN, M.D.
Auburn, N. Y.

TECHNIC

Diagnostic Possibilities of Lymphangiography. R. Gergely, Z. Zsebök, and M. Földi. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 85: 175-181, August 1956. (In German) (Z. Z., I. Chirurgische Klinik, Universität zu Budapest, Budapest, Hungary)

Bilateral edema is usually a chemical edema—angio-neurotic, anaphylactic, or inflammatory—and thus is not particularly dependent upon any local phenomenon. Unilateral edema is practically always mechanical in origin and is amenable to local investigation. If a suitable method of lymphangiography could be found, it would supplement arteriography and venography in the investigation of these cases. Unfortunately, a lower extremity lymph vessel is less than a millimeter in diameter, is thin-walled, and is filled with such totally colorless lymph that it is practically invisible. Direct needling is almost impossible.

Recently it has been demonstrated that liquids injected either subcutaneously or subserosally rapidly enter the afferent lymph vessels. This process is hastened by hyaluronidase. On this principle Kim-month *et al.* have developed a method of demonstrating the lymphatics (*Brit. M. J.* 1: 940, 1955. *Abst. in Radiology* 66: 311, 1956). A blue dye such as methylene blue is injected subcutaneously and the area is massaged. Fifteen minutes later a shallow skin incision is made and the edge of the incision is inspected for a lymph vessel which can be identified by the methylene blue. When this procedure is successful, a fine-bore needle can be inserted into the lymphatic and a contrast medium such as Diodrast injected. By this method, the lymphatics can be outlined and the afferent vessels are noted to fill very rapidly. Exposures must be taken at the termination of the injection exactly as in the case of a venogram.

Clarification of the normal anatomical conditions by this means was found helpful for the correct interpretation of the appearance of the lymphatics in various diseases of the lower extremities.

Ten roentgenograms.

WILLIAM F. WANGNER, M.D.
Royal Oak, Mich.

Dangers and Technic of Osteomyelography and Transosseous Venography. H. J. Süss. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 85: 181-187, August 1956. (In German) (Universitäts-Röntgeninstitut Leipzig, Leipzig, Germany)

The veins may be demonstrated (1) by arteriography, i.e., by the injection of a contrast medium into an artery

with exposure of the roentgenogram during the venous recurrent phase; (2) by intravenous venography, with exposures during injection of the medium into a vein; (3) by organ venography, in which the injection is made directly into the spleen, the bone marrow, or the corpora cavernosa. Bone marrow venography has two advantages. In the first place, it does not involve the necessity of locating a vein; in the second place, it permits the demonstration of some veins which cannot be shown by direct injection, as the internal iliac vein, the internal mammary vein, the intercostal vein, the vertebral plexus, the deep veins of the leg, and the azygos vein.

Complications which have arisen by reason of inserting a needle into a bone include injury of an adjacent structure such as the aorta, the spinal cord, or the urinary bladder. Back leakage with persistent bleeding along the puncture track may also occur. In one instance osteomyelitis is known to have developed. As far as the modern contrast media are concerned, very little local effect is produced. Minimal fibrosis can be detected but is apparently inconsequential. Injections into areas of fibrous dysplasia, Paget's disease, and bone cysts have been performed without complications. Phlebothrombosis may occur in the vein leading from the bone. This may be avoided by not exceeding 50 per cent concentration of the medium and omitting compression.

The author knows of one instance in which the development of arteriosclerotic gangrene of the foot was attributed to osteomyelography of the tibia. Theoretically, fat emboli, blood emboli, and tumor emboli could occur. Regardless of what bone is injected, general anesthesia is the only humane way in which the procedure can be performed, since bone pain is definite and severe. In considering the dangers of this type of venography, the hazards of narcosis must be added to the surgical and the chemical.

The author concludes that for routine purposes intravenous venography is the procedure of choice. Except for purely scientific purposes and then only in a volunteer patient should transosseous venography be performed.

Four roentgenograms.

WILLIAM F. WANGNER, M.D.
Royal Oak, Mich.

A New Method of the Measurement of Objects by X-Rays with Special Reference to Pelvimetry. J. S. Coller. *South African M. J.* 30: 788-790, Aug. 18, 1956. (Durban, Union of South Africa)

The author describes a method for general use in problems of x-ray measurement, which is perhaps most helpful in pelvimetry, though it is useful also in the assessment of shortening in a fractured leg. The apparatus, which is readily adapted to any normal x-ray equipment, consists of two perforated steel rulers, moving at right angles to a vertical film in the upright Bucky stand, the distance of the rulers from the film being infinitely variable. The technic for both pelvimetry and measurement of the long bones is described. The author concludes: "While further use of this technic may show up disadvantages, it is seen that for the purposes of measuring only, such things as compasses, perforated lead sheets, stereoscopes, pantoscopes, reconstruction charts, nomograms, transfer scales, plumbobs etc., are completely unnecessary. . . . The greatest advantage in practice is that the time taken to measure

each diameter in centimetres and in inches is very drastically reduced."

One photograph.

Cerebral Cine-Angiography with the Image Intensifier. H. Verbiest and J. Feddema. *Acta radiol.* 46: 310-314, July-August 1956. (University Hospital, Utrecht, Holland)

The authors describe an experimental image intensifying tube with a useful screen diameter of 270 mm. This tube has been used to perform cine-roentgenography of the cerebral circulation. To record the image, a camera using a mirror optical system is utilized. The mirror system has the following advantages: it is free from chromatic aberrations; it has a large light-gathering power; and 35-mm. film is used because it is a standard size and can be employed with standard equipment. The quality of the image is better than with small films. With larger film sizes more information might be obtained, but the intermittent movement of the film then becomes impracticable.

With a six-valve apparatus, 0.3 mm. focus tube, and 1 mm. Al filter, the best exposures were obtained at 72 kv. Eighteen ma were utilized in an exposure rate of 16 frames per second. The total dose of radiation during 25 seconds of filming amounted to 6.5 r, with an

additional 3 r being used for positioning of the head.

[See also Verbiest *et al.*, *Rev. mex. de radiol.* 9: 47, 1955. *Abst. in Radiology* 66: 150, 1956.—Ed.]

One roentgenogram; 1 drawing.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

The Technic of Making Microangiograms of Rabbit Bone Marrow. Chiyeko Okawa and J. I. Trombka. *Am. J. Clin. Path.* 26: 758-764, July 1956. (Medical Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tenn.)

The preparation of microangiograms of the bone marrow is technically more exacting and requires more time than of certain other tissues, such as kidney or liver. This is chiefly because of the greater difficulty in removing or sectioning the bony cortex and the fragility of the marrow. The authors describe a method which they have found satisfactory. Inasmuch as particles of different dimensions are needed for outlining vessels of varying sizes, the radiopaque material used is a mixture of barium sulfate and gelatin. This mixture was infused into the aorta of the rabbit, and roentgenograms of celloidin sections of the bone marrow were made with a low-voltage x-ray diffraction unit.

One microangiogram; 1 photograph; 1 diagram.

RADIOTHERAPY

Carcinoma of the Tongue. Treatment and Results Without Radical Surgery. Frank C. Marchetta and Walter L. Mattick. *Surgery* 40: 378-386, August 1956. (Roswell Park Memorial Institute, Buffalo, N. Y.)

A clinical study was made of 247 consecutive cases of carcinoma of the tongue treated by irradiation at the Roswell Park Memorial Institute from 1937 through 1944. During this period, no radical surgery was performed, though in 18 cases an excisional rather than a punch biopsy was done. As soon as the diagnosis of carcinoma was confirmed, however, these cases received a full course of irradiation.

The youngest patient in the series was twenty-eight years of age and the oldest eighty-eight. The usual etiologic factors conspicuous in chronic glossitis, either singly or in various combinations, were present: use of tobacco, poor oral hygiene, leukoplakia, avitaminosis, a history of syphilis and/or a positive blood Wassermann reaction. In 18.2 per cent of the cases the serologic test was positive on admission and these patients were presumed to have had a syphilitic glossitis at some time prior to the development of cancer. In most instances the cancer was rather advanced, which often made it difficult to determine its point of origin.

Various forms of irradiation were employed. In some cases, in which the tongue mass was infiltrative, interstitial radon seeds or radium needles were used. In others, especially when the growth was of the exophytic type, intraoral x-ray therapy was given.

There were 41 cases in which the tumor involved the lateral portion of the anterior third of the tongue. Nine of the 30 patients (30 per cent) without palpable nodes lived more than five years. None of the 11 patients with palpable nodes on admission survived for five years. The overall five-year survival for this entire group was 22.0 per cent.

In 99 cases the lesion originated on the lateral mid-

third of the tongue. There again none of the 37 patients with palpable nodes on admission lived five years. Seventeen of the 62 patients (27.4 per cent) without palpable nodes survived five years. The five-year overall survival for this group was 17.1 per cent.

Lesions involving the lateral portion of the posterior third of the tongue totaled 58. Two of the 27 patients (7.4 per cent) with palpable nodes and 10 of 31 (32.2 per cent) with no nodes survived five years. The overall five-year survival was 20.7 per cent.

In 41 cases the lesion originated in the right or left base. Two of 30 patients (6.6 per cent) with palpable nodes and 2 of 11 (18.1 per cent) without lived more than five years. The survival rate for the group was 9.8 per cent.

In 8 cases the entire tongue was involved and frozen in the floor of the mouth. Strangely enough, 2 of these patients had no palpable nodes on admission. None, however, lived five years.

Less favorable results were obtained in patients with cancer of the base of the tongue than in those with cancer on the oral portion. Sixty per cent of the lesions on the base of the tongue were of Grades I and II and 40 per cent of Grades III and IV, whereas 82 per cent of the lesions on the oral tongue were Grades I and II, and 18 per cent were Grades III and IV. The absolute survival rate for patients with lesions on the oral portion of the tongue was 19.2 per cent; in cases without neck nodes, 29.3 per cent. The absolute survival rate for patients with lesions on the base of the tongue was 9.8 per cent.

Forty per cent of the 247 tumors were of Grade I (Broders' classification), 38 per cent Grade II, 16 per cent Grade III, and 5 per cent Grade IV. The survival rate was definitely better in patients with lesions of Grades I and II. However, survival appeared to be more closely related to the presence or absence of meta-

static nodes at the time of treatment. One hundred and thirty-six patients had no nodes on admission, and 28 per cent of these lived for five years. Of the 111 patients with nodes, only 3.6 per cent lived five years. These figures indicate that radiation can hope to cure only an occasional case when the patient is first seen with clinically palpable metastases.

Sixteen and two-tenths per cent of all patients were free of disease for five years or more. This figure is approximately 10 per cent lower than that in clinics where irradiation is supplemented by radical surgery. The authors believe that the more radical surgical approach (hemiglossectomy, hemimandibulectomy, and neck dissection) is often necessary to improve the overall end-results.

Two figures; 3 tables.

The Special Problem of Cancer of Eyelid. Orliiss Wildermuth and John C. Evans. *Cancer* 9: 837-841, July-August 1956. (Tumor Institute of Swedish Hospital, Seattle, Wash.)

The authors report the results of radiation therapy in 81 patients with cancer of the eyelid seen at the Tumor Institute of the Swedish Hospital in Seattle. There were no irradiation-induced complications. Epiphora occurred in 10 patients with carcinoma in or about the nasolacrimal duct. Ten photographs show the excellent functional and cosmetic results which were obtained in these patients.

The authors state that failures to control the lesion are discovered during the first year after treatment and that close observation during this period is required. In 71 determinant cases, judicious application of irradiation and surgery permitted a 97.3 per cent control. Irradiation is considered the best method of treatment not because of a cure rate superior to that obtained with surgery, but rather because superior cosmetic and functional results are obtained. JAMES E. BAUER, M.D.
University of Missouri

The Influence of Histologic Type on Survival Following Radiotherapy of Bronchogenic Carcinoma. Eugene R. Kutz. *J. Thoracic Surg.* 32: 165-170, August 1956. (Allegheny General Hospital, Pittsburgh, Penna.)

One of the few conclusions about radiotherapy of bronchogenic carcinoma generally accepted is that it is never curative. In fact, few patients have survived more than five years. A second conclusion about which there is general but not unanimous agreement is that radiotherapy seems to prolong life, even though this is often for several months only.

The author has studied the survival time—from the first treatment to death—in a series of 50 proved cases of bronchogenic carcinoma. All fifty of these patients were treated with a 400-kv constant-potential x-ray generator, h.v.l. 6.5 mm. Cu. With a beam of this quality, 5,000 to 6,000 r can be delivered to the tumor through two or three ports. The 50 cases were divided into histological groups: 20 undifferentiated carcinomas, 18 squamous-cell carcinomas, 3 adenocarcinomas, 9 cell type unknown but malignant.

The group of undifferentiated carcinomas proved the ineffectiveness of treatment of this type of lung tumor. No patient survived over eleven months. The average survival time was only 4.7 months. Five patients received over 5,000 r tumor dose with an average survival of 4.8 months. The other patients received between 5,000 r and less than 3,000 r tumor

dose. The fact that the average survival time of the whole group is almost identical with the survival time of the 5 patients treated with more than 5,000 r suggests that there is no correlation between total dose and survival rate in these cases.

The group with squamous-cell carcinoma was more encouraging. The average survival time was 11.4 months. Seven of the 18 patients received over 5,000 r tumor dose, the others between 5,000 r and less than 3,000 r. It is difficult, however, to draw any conclusions concerning the relationship between total doses and survival time because of many immeasurable factors, such as the extent of the tumor, the presence of metastases, the location of the tumor, and the condition of the patient.

The average survival time for the three patients with adenocarcinoma was 8.3 months. The histologically unknown group of 9 cases had an average survival time of 4.6 months, which is as poor as the undifferentiated group. The reason for this is probably the very poor condition of most of these patients.

From this series it is evident that vigorous radiotherapy to squamous-cell carcinoma of the lung is justified. On the other hand, radiotherapy of undifferentiated carcinoma is of doubtful value even in selected cases.

Three roentgenograms; 1 graph; 3 tables.

JOACHIM GFOELLER, M.D.
Cleveland City Hospital

Carcinoma of the Oesophagus and Gastric Cardia. Denis Fuller. *South African M. J.* 30: 776-788, Aug. 18, 1956. (Johannesburg General Hospital, Johannesburg, Union of South Africa)

The author reviews current trends in the surgical and radiation treatment of carcinoma of the esophagus and gastric cardia. Etiology, pathology, and symptoms are also considered.

Observations in 80 cases seen at the Johannesburg General Hospital during the five years previous to the present study are reported. The results in the 22 patients undergoing radiotherapy were disappointing. Only 2 patients survived for longer than one year, and in these biopsy at esophagoscopy was negative.

Investigative procedures for determining the presence of the condition include barium swallow and roentgen studies. It is emphasized that a small lesion may be missed on screening, and that carcinoma of the gastric cardia is notoriously difficult to visualize radiologically. Esophagoscopy is regarded as the most important single diagnostic procedure; it should be employed in all cases of dysphagia where no clear-cut radiological or clinical diagnosis can be made. In the present series, a positive histologic diagnosis was obtained in all but 4 of the cases examined.

Radiation treatment is given to patients with squamous-cell esophageal carcinoma. Adenocarcinoma of the cardia rarely, if ever, responds to radiation. Four radiation techniques are outlined: (a) Teleradiation is employed most often, with a dose of approximately 6,000 r delivered to the tumor through multiple ports. (b) Intracavitary irradiation, which provides a high local dose without producing the severe constitutional disturbances often observed following teleradiation, generally succeeds in destroying the primary lesion at a dose of 6,000 r at 1 cm. Either radioactive cobalt in a suitable container or radium needles are employed. (c) Radon seeds or radium needles may be inserted into

the tumor. Because of the difficulty of access to the distal end of the carcinomatous stricture, this procedure is unlikely to be of much use, except possibly for small local growths. (d) High-voltage radiation is delivered by machines producing a voltage of one million and more. The practical and theoretical considerations are much the same as those for telerradiation with conventional equipment, and the recorded results appear to be no better.

The author believes that, because of the high percentage of resectable lesions, radiation as the sole curative measure must be subordinate to surgery unless and until better results with radiotherapy are achieved. As a palliative measure, however, radiotherapy is invaluable. It will diminish the size of the growth, may destroy the primary lesion completely, and remove symptoms associated with the inability to swallow.

Four roentgenograms; 11 tables.

A Study of 531 Cases of Endometrial Carcinoma.

John H. Randall and William B. Goddard. Surg., Gynec. & Obst. 103: 221-226, August 1956. (Department of Obstetrics and Gynecology, State University of Iowa Hospitals, Iowa City, Iowa)

From January 1926 to January 1951, 531 patients with endometrial carcinoma were admitted to the University of Iowa Hospitals for treatment. Of these, 516 were treated, with a five-year survival rate of 55.2 per cent.

Endometrial carcinoma in this series was essentially a postmenopausal disease. Only 20 per cent of the patients were still menstruating. Less than 3 per cent were under forty.

One hundred twenty-eight women had never been pregnant (26.0 per cent), from which fact the authors conclude that child-bearing decreases the chances for acquiring the disease. Obesity and a late menopause, on the other hand, are held to favor its occurrence: 58 per cent of the patients were obese, weighing 170 pounds or over, and 58 per cent were considered to have had a late menopause (after fifty).

The most common initial symptom was vaginal bleeding (95 per cent), and it is stressed that a benign lesion should never be offered as an explanation for metrorrhagic bleeding until a malignant growth has been excluded.

Intracavitary radium application followed by hysterectomy yielded better results than hysterectomy alone, or radium alone, or hysterectomy combined with roentgen therapy. One hundred ninety-four patients were treated with intracavitary radium followed by hysterectomy six to eight weeks later; 75.8 per cent survived five years. Ninety-nine patients were treated by hysterectomy alone, or by hysterectomy combined with roentgen therapy, with a five-year survival of 58.5 per cent. Seventy-one patients were treated by radium alone, with a five-year survival of 49.3 per cent. Preoperative and postoperative roentgen therapy each proved less efficacious than intracavitary radium prior to operation. For 59 patients treated by roentgen irradiation and hysterectomy, the five-year survival was 57.6 per cent. In a group of 76 patients with advanced disease the five-year survival rate was 23.6 per cent following radium or roentgen therapy alone.

The procedure is to pack the uterine cavity with multiple foci of radium, each containing 10 mg. of radium filtered with 1.0 mm. of platinum. The radium is applied immediately following a diagnostic curettage

and is allowed to remain for three days if a 24-hour pathological report confirms the impression of malignancy. Hysterectomy is done six to eight weeks later.

Multiple foci of radium were found to be more effective in sterilizing the uterine cavity than a tandem applicator. Seventy-six patients were treated with a tandem, and in 25 of these (33 per cent) the removed uterus showed no residual cancer. Of 132 patients treated with multiple foci, 82 (62.1 per cent) had complete sterilization. The five-year survival for those with residual carcinoma after multiple foci of radium had been used was 61.3 per cent as compared to 76.3 per cent for those in whom the uterus showed no demonstrable remaining disease.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Moving Field Therapy of Gynaecological Tumours in the Pelvis. H.-J. Maurer. J. Indian M. A. 27: 123-126, Aug. 16, 1956. (Radiological Institute of the University Hospital for Gynecology and Obstetrics, Erlangen, Germany)

In a consideration of moving field therapy of gynecologic pelvic tumors, the author finds irradiation by a combination of pendulum and convergent beam therapy ("Pendel-Konvergens" or PK) to be the optimal method with the usual qualities of radiation. The skin, bladder, and rectum are spared and a better dose distribution is obtained.

While the experiments of Schinz and Wideröe (Strahlentherapie 95: 33, 1954. Abstr. in Radiology 65: 150, 1955) showed pendulum motion with 31-MEV x-rays to be unfavorable, the author's measurements proved that these disadvantages are avoided in pendulum therapy with 15 MEV.

Technical data for the various methods of irradiation are given, especially as concerns the iliac and para-aortic lymph nodes.

Six figures; 3 tables.

Contribution to Radiotherapy of Xanthomatous Giant-Cell Tumors. Sven Hultberg and V. Belloch Zimmermann. Strahlentherapie 100: 489-495, 1956. (In German) (Radiumhemmet, Stockholm, Sweden)

The authors report 8 cases of xanthomatous giant-cell tumors treated by irradiation in the Radiumhemmet, Stockholm, between 1937 and 1950. Four patients were well from five to eighteen years after radiotherapy. In 3 of these cases the lesion occurred at the knee, and in one case at the talocrural joint. A minimal dose of 2,000 r/O is necessary to avoid recurrences.

One photomicrograph; 4 photographs.

LEWIS L. HAAS, M.D.
University of Illinois

Rare Bony and Parosteal Tumors in Which Radiotherapy Is Not Indicated. Willy Baensch. Strahlentherapie 100: 512-517, 1956. (In German) (Georgetown University Medical Center, Washington, D. C.)

Osteoid osteoma, parosteal osteoma, and synovioma do not respond to radiotherapy. Irradiation therefore is not recommended in these diseases and radical surgery should be carried out as early as possible. Two cases of synovioma are reported.

Four roentgenograms; 1 photomicrograph; 1 photograph.

LEWIS L. HAAS, M.D.
University of Illinois

The Treatment of Dupuytren's Contracture. Karl Wasserburger. *Strahlentherapie* 100: 546-560, 1956. (In German) (Krankenhaus der Stadt Wien-Lainz, Vienna, Austria)

The Dupuytren contracture occurs mainly in males over forty years of age. Similar lesions of the foot, and induratio penis plastica may also be observed in the same patient. The author irradiated 213 cases from 1937 to 1953 with 400 mg. radium element at 2 cm. radium-skin distance. A 1,089 r skin dose was delivered in two hours. This dosage was repeated if necessary after three to six months, up to three times in one year.

Three stages of the disease were differentiated: (I) initial limitation of finger movements; (II) fixed strand formations in the palmar fascia, with early contracture; (III) advanced contracture of the fingers.

In follow-up examinations over long periods of time, 69.8 per cent of the patients proved to be free from symptoms: 89.8 per cent of those in Stage I; 56.5 per cent of those in Stage II; 32.2 per cent of those in Stage III. The author stresses the importance of early treatment.

Nine tables.

LEWIS L. HAAS, M.D.
University of Illinois

The Radiologist Facing Evident and Latent Thymic Hypertrophy. Giovanni F. Gardini and Roberto Betti. *Radiol. med.* 42: 794-799, August 1956. (In Italian) (Bologna, Italy)

The authors report a series of "over 200" patients (62.5 per cent males and 37.5 per cent females) with hypertrophied thymus, but are able to supply statistical data for only 181 (25 younger than one month, 49 between one and three months, 46 between three and six months, 24 between six and twelve months, and 37 older than one year). The following symptoms were present: "dysthelasia" [presumably difficulty in sucking] in 116 (57.1 per cent), dyspnea in 81 (39.9 per cent), perioral cyanosis in 72 (25.6 per cent), exudative diathesis in 32 (15.7 per cent), inspiratory stridor in 20 (9.8 per cent), habitual vomiting in 19 (9.3 per cent), anorexia in 17 (8.3 per cent), asthma in 11 (5.4 per cent), convulsions in 9 (4.4 per cent), and angioma [hemangioma?] in 9 (4.4 per cent). Frequent singultus was present in almost every instance, and laryngeal cough in a few.

Eighty patients received radiation treatment, but this was adequately completed or properly followed up in only 64. "The technical data were those of a penetrating roentgen therapy." One cycle consisted of four times 50 r given at 15-day intervals. If symptoms failed to disappear promptly, one or even two additional cycles were administered. The symptoms which responded best were habitual vomiting, apnea, stridor, dysthelasia, asthma, and feeding disturbances.

The authors' conclusions are translated literally: "The finding of enlarged thymus is not always proportional with the disturbances. The thymus is very (radio)sensitive, but shows a tendency to recurrent enlargement. Roentgen therapy is absolutely innocuous, even in the first days of life, provided it is conducted with the necessary caution. Irradiation is not necessarily indicated every time there is enlargement of the thymus, but only when the symptomatology requires it. When faced with habitual vomiting associated with thymic hypertrophy, one must irradiate as an emergency. The doses must be low. In

status thymico-lymphaticus it is recommended that thymic irradiation be combined with tonsillar roentgen therapy."

Eight roentgenograms; 9 drawings; 3 tables.

[This article is actually unsuitable for abstracting because of its incomplete and erratic data. It seemed, however, of interest to present a European point of view, even though it appears that the authors are totally unaware of the controversial opinions expressed in the recent literature regarding the possibility that thymic irradiation may have late carcinogenic effects, for instance on thyroid tissue.—E. R. N. G.]

E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

Augmenting Effects of Radiation Therapy by Chemotherapy and Other Agents. Raymond R. Lanier, Richard W. Whitehead, and Jane H. Gum. *Acta radiol. interam.* 5: 48-53, October-December 1955. (R.R.L., 4200 E. Ninth Ave., Denver 20, Col.)

The authors stress the necessity of more fundamental work in radiation biology in search of aids to modify tumor response to irradiation. Summarizing some of the significant contributions in this field, they mention measures to insure an optimum blood supply, dietary regulation, and the use of drugs, vitamins, and hormones. They themselves conducted some fifty experiments with nine different compounds, leading them to the conclusion that tumor growth in mice is modified more by a combination of certain drugs and roentgen rays than by either alone, and that pure O₂ inhalation increases the response.

The best results in this series of studies were obtained with a urethane derivative (No. 738), triethylene melamine (TEM), α -tocopherol, and 6-mercaptopurine, though the two latter compounds had not been used in a sufficient number of animals to warrant a final opinion.

In view of their observations, the authors believe that chemotherapy can make irradiation therapy a more effective agent in the treatment of malignant neoplasms in man.

JOSEFA DEL CARMEN, M.D.
St. Vincent's Hospital, New York

Utilization of a 31-MEV Betatron for Radiation Therapy. I. History, Principles, Installation, Protection. B. Bellion, C. Tribuno, and A. Torretta. *Radiol. med. (Milan)* 42: 800-813, August 1956. (In Italian) (Servizio Radiologico, Clinica Medica Generale dell'Università di Torino, Turin, Italy)

The first betatron operated in Italy is a 31-MEV model, manufactured by Brown-Boveri, and installed under the sponsorship of the Italian National Research Council in its Center for Biophysical Studies (attached since May 1954 to the University of Turin). This introductory note contains information on the physical data, protection required and provided, and adjustment of the installation to local conditions.

Seven drawings; 3 photographs, 1 table.

E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

Studies of Dose Distributions in Water for Betatron X-Rays up to 37 Mev. B. Zendle, H. W. Koch, J. McElhinney, and J. W. Boag. *Radiation Res.* 5: 107-126, August 1956. (National Bureau of Standards, Washington, D. C.)

Dose-distribution measurements were obtained in

water for finite width x-ray beams of maximum energy of 11, 16.2, 20.3, 23.8, 28.5, 33.6, and 37 MEV, an $8 \times 8 \times 5$ -mm. anthracene crystal and a 25-r Victoreen thimble chamber being used as detectors. Measurements made to 1-meter depth indicated proportionality of response between the two detectors for 37 MEV, the only case where a comparison was made. Measurements of the dose from radiation scattered to the central axis in Masonite for annular x-ray beams of various mean radii made possible the correction of the dose-distribution data for the 14-cm.-diameter beam to what they would have been for a uniform beam of infinite extent.

Measurements of the x-ray beam flux with a secondary standard whose response was calculated and calorimetrically calibrated permitted evaluation of a dose conversion factor of 92.4 ergs/gm. of water per esu/cm.² of ionization measured in an air cavity in the water. This was accomplished by a linear integration of the 37-MEV broad-beam ionization dose-distribution function, normalized to the incident x-ray energy per unit area. The value calculated from the Bragg-Gray relation for 37-MEV x-rays is 93.5 ergs/gm. per esu/cm.². The experimental value agrees with this value within the expected experimental uncertainty discussed in the section on errors. The broad-beam dose-distribution data agree with Brysk's detailed calculations of the energy dissipation distribution in water for 40-MEV bremsstrahlung (Phys. Rev. 96: 419, 1954).

The Scintillation Spectrometer, a Measuring Instrument in Radiological Practice. Walter Kolb. *Röntgen-Blätter* 9:241-254, August 1956. (In German) (Physikalisch-Technische Bundesanstalt, 100 Bundesallee, Braunschweig, Germany)

The spectral composition of a roentgen beam is still

most accurately determined by crystal (grid) spectrometry, which establishes a curve from the wave lengths of the component radiations. The method is so delicate and time-consuming, however, that in practice it is replaced by measurement of the first and second half-value layers, with a statement as to kilovoltage, wave form, and filtration. This is often inadequate when a large bremsstrahlung is emitted as the characteristic radiation of the anticathode.

In recent years the scintillation counter, a standard instrument in the measurement of radioactivity, has been adapted to roentgen spectrometry. In this case, however, the energy, rather than the wave length, of each component radiation is evaluated. When the intensity of the beam is kept adequately low, the photomultiplier tube will deliver electrical impulses, each being proportional to the energy of the respective quanta, which is of advantage from a physical as well as practical point of view.

As with any scintillation counter, there is need for a thallium-activated sodium iodide crystal, adjusted to the quality of the beam. The photomultiplier tube must be connected to an impulse height analyzer, so as subsequently either to (1) count the events for each level of energy (impractical because time-consuming); (2) inscribe the heights by coupling a rate meter to a kymograph (the most accurate); or (3) visualize the curve with the help of an oscilloscope (highly demonstrative, and sufficiently sensitive for orientation purposes).

The procedure has several interesting practical applications, notably the visual evaluation of the influence of the filter and of various anode materials on the composition of the roentgen beam.

Twelve illustrations. E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

RADIOISOTOPES

Technical Considerations in I¹³¹ Tracer Studies. Robert E. Beck, John Kronsbein, and Arthur A. Hobbs, Jr. *J. Clin. Endocrinol.* 16: 1102-1108, August 1956. (Protestant Deaconess Hospital, Evansville, Ind.)

An analysis of 364 consecutive tracer studies performed on 302 patients was made from the point of view of accuracy, ease of performance, and correlation with clinical status. Tracer technics tried and analyzed included contact counts made at various intervals over the thyroid gland, counts of urinary excretion of I¹³¹ in separately voided specimens, and half-hour thyroidal increment tests adapted from Berson's method of determining rate of plasma clearance.

Tracer doses of I¹³¹ were given intravenously or orally in quantities of 50 to 100 microcuries. Thyroid uptake values at twenty-four hours showed a relatively large overlap between hyperthyroid and euthyroid patients, so that a considerable percentage of cases studied were inadequately differentiated. A similar relatively wide overlap was found in counting urine samples for iodine excretion in hyperthyroid and euthyroid patients. Plasma clearance data likewise were not sufficiently accurate for differential diagnosis. Hypothyroidism was even less well separated from euthyroidism.

The most accurate results, based on clinical correlation, were obtained by making uptake counts at two, four, eight, and twenty-four hours following intravenous injection of the tracer, utilizing a Geiger-Müller end-

window tube at 30 cm. distance from the thyroid. Specifically, counting intervals of four and eight hours after administration of the tracer allowed the greater diagnostic discrimination and offered some increased convenience to the patient.

Three diagrams; 2 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Determination of Radioiodine Uptake in Thyroids by Two Methods. Egilda DeAmicis and Earle W. Williamson. *J.A.M.A.* 161: 1377-1379, Aug. 4, 1956. (Cancer Research Institute, New England Deaconess Hospital, Boston, Mass.)

The authors compared thyroid uptake measurements obtained at twenty-four and forty-eight hours with a four-tube Geiger-Müller counter and with a single scintillation counter in 55 patients. The count obtained was compared to the count of a sample of radioiodine equal in strength to that which the patient had received, and was corrected for background count. Statistical analysis showed the differences in twenty-four-hour and forty-eight-hour uptake readings on the same subject, performed within a thirty-minute interval with the two instruments, to be in close agreement, any discrepancies being well within the limits of chance variation.

JAMES E. BAUER, M.D.
University of Missouri

Pneumo-Thyroid: A New Procedure for Determining the Mass of the Thyroid Gland for the Radioiodine Treatment of Hyperthyroidism. Victor Hugo Franco and Mario Gentil Quina. *Brit. J. Radiol.* 29: 434-439, August 1956. (Laboratório de Isótopos, Instituto Portugues de Oncologia, Lisbon, Portugal)

A technic is presented by which the mass of the thyroid gland can be determined for the purposes of I^{131} dosage estimation. This involves insufflation of oxygen into the infrahyoid region, following which roentgenograms in two perpendicular planes and, if necessary, tomograms are obtained.

Geometric calculations of the mass of the thyroid can then be made by (a) evaluation of parallel sections of the area with a planimeter; (b) reconstruction of the volume of the gland by superimposition of the sections representing the tomographic pictures and filling the spaces between with plastic material; (c) utilizing the formula that gives the volume of a scalene ellipsoid ($4/3 \pi \times A \times B \times C$, where A, B, and C represent the semi-axes). The volume of the thyroid as determined by any one of these methods was found to agree within 10 per cent with that of the surgically removed specimen. The authors prefer to use the formula for the volume of a scalene ellipsoid because of its simplicity. The method of determination of the axes is described.

The accuracy of the calculations is borne out by the fact that in no instance have the authors encountered hypothyroidism following the first therapeutic dose of I^{131} calculated on this basis. The procedure is believed to be contraindicated in patients with obvious cardiac insufficiency.

Eleven roentgenograms; 1 photograph.

STEPHEN N. WIENER, M.D.
Mt. Sinai Hospital, Cleveland, Ohio

Radioiodine Uptake in the Diagnosis of Thyroiditis. Elmer C. Paulson. *Minnesota Med.* 39: 387-388, June 1956. (Department of Radiology, University of Minnesota, Minneapolis, Minn.)

The difficulty in differential diagnosis between subacute thyroiditis and a toxic goiter is well known. The author reports a study of 10 cases of thyroiditis by the I^{131} uptake method. Two of these were regarded as classic cases of thyroiditis. Pathological confirmation of the diagnosis was obtained in 3 others. Two cases, which subsequently proved to be Hashimoto's struma, had uptakes which were in the lower portion of the normal range. In the other 8 cases the uptakes were definitely subnormal, 5 of them being consistent with myxedema. In general, the uptake in Hashimoto's struma is of dubious diagnostic value since the range may be from subnormal to high. The I^{131} uptake in subacute thyroiditis is depressed below normal as a reflection of a poorly functioning thyroid. The test is a useful guide in treatment, since it indicates when supplemental whole thyroid should be given.

One table.

RICHARD F. MCCLURE, M.D.
Redondo Beach, Calif.

Cancer of the Thyroid Gland. Donald E. Ross. *Surg., Gynec. & Obst.* 103: 171-179, August 1956. (947 W. Eighth St., Los Angeles, Calif.)

Forty cases of proved cancer of the thyroid were found by the author in 1,000 thyroidectomies performed between 1945 and 1955, an incidence of 4 per cent. The average age was forty-one years; 7 patients (17.5 per cent) were less than twenty. Twenty-six

(65 per cent) were females. Eight patients were clinically toxic, refuting the theory that toxicity precludes the presence of cancer. At the time of the report, 7 of the series had died.

Total thyroidectomy should be performed in all cases of thyroid cancer, with block dissection of the nodes on the side involved. Seventeen of 24 block dissections (71 per cent) in this series revealed metastases. If the nodes prove to be involved, then those of the opposite side are also dissected. If encapsulated adenomas are found to be malignant, the same procedure of radical thyroidectomy combined with block dissection is followed, since these may metastasize via the lymphatics. The author feels that adequate substitution therapy makes it unnecessary to leave even a small piece of thyroid tissue, which he condemns as dangerous, since it may contain malignant cells.

Radioactive Iodine, I^{131} . The normal range of uptake of iodine by the thyroid is from 10 to 35 mg. per cent. Thyrograms are useful in demonstrating radioactive iodine within the gland. A filling defect may be due to fibrosis, cystic degeneration, or non-functioning adenoma, or it may indicate a malignant nodule. The author believes that the uptake of radioactive iodine is never good enough to justify its sole use for treatment in cancer. Uptake is poorest in the papillary type of cancer and best in the alveolar type. After the thyroid gland has been removed, a thyrogram is taken and if residual areas are found they may be ablated with a therapeutic dose of radioactive iodine. The author believes that the preliminary use of thyrotropic hormone increases the uptake of iodine and enhances its therapeutic effect on the metastases.

Ten illustrations; 7 tables.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

The Metabolism of Iodotyrosines. II. The Metabolism of Mono- and Di-Iodotyrosine in Certain Patients with Familial Goiter. John B. Stanbury, J. W. A. Meijer, and A. A. H. Kassenaar. *J. Clin. Endocrinol.* 16: 848-868, July 1956. (J. B. S., Massachusetts General Hospital, Boston, Mass.)

The fate of I^{131} and of labeled mono- and di-iodotyrosine was studied in 3 patients having hypothyroidism and congenital goiter, and in 5 euthyroid relatives of 1 of the 3 patients. Uptake of radioactive iodine was measured over the thyroid gland, and the blood serum and urine were studied chromatographically. In the 3 goitrous hypothyroid patients, I^{131} administered orally was rapidly accumulated by the thyroid and appeared in the serum and urine as mono-iodotyrosine, as di-iodotyrosine, and as two unidentified components which, upon hydrolysis, yielded mono-iodotyrosine. Intravenously administered di-mono-iodotyrosine appeared in the urine either in unchanged form or as unidentified substances, one of which yielded mono-iodotyrosine upon hydrolysis. A small fraction of the labeled mono-iodotyrosine was de-iodinated. Labeled di-di-iodotyrosine, when given intravenously, appeared in the urine almost entirely unchanged, and there was no evidence of de-iodination. In the 5 euthyroid subjects (4 with goiter) radioactive iodine-labeled di-iodotyrosine was de-iodinated, but more of the injected dose appeared in the urine than was expected.

Study of these findings suggests that the 3 patients were unable to de-iodinate di-iodotyrosine and that they exhibited defective de-iodination of mono-iodo-

tyrosine. As a consequence, they showed unusually rapid uptake and turnover of I^{131} by the thyroid gland. The thyroid glands of the euthyroid relatives were probably secreting mono- and di-iodotyrosine into the blood, but, since iodide could be recouped after deiodination in the periphery, a state of iodine deprivation did not develop.

Eleven graphs; 3 tables.

RICHARD F. McCLURE, M.D.
Redondo Beach, Calif.

Therapy of Serous Cavity Effusion with Colloidal Radioactive Gold 198. Edward P. Engels, E. C. Paulson, and Donn G. Mosser. *Minnesota Med.* 39: 521-523, August 1956. (D. G. M., 412 Delaware St. S.E., Minneapolis 14, Minn.)

Effusions in the pleural and peritoneal cavities are a commonly encountered problem in patients with advanced malignant disease. Carcinoma of the breast and ovary are most frequently responsible for these fluid accumulations. The authors have used radiogold in 31 patients with carcinomatous effusions: 14 peritoneal and 19 thoracic (in 2 patients both peritoneal and thoracic effusions were treated).

A decrease in the amount of effusion following the treatment for a period of at least two months was interpreted as a successful result. Cases in which death occurred within five weeks following treatment were not subject to classification. Among the 14 cases of peritoneal effusion, results were successful in 6 instances, 5 were regarded as failures, and 3 were unclassified. In the group of 19 pleural effusions, results were successful in 10 cases; there were 6 failures, with 3 unclassified.

The authors' experience indicates about 50 per cent improvement in patients suffering from carcinomatous effusions. This coincides with the results reported from several other institutions. It is emphasized that this treatment aims only at palliation of the effusion and does not alter the general course of the disease. Such palliation can also be achieved by other agents, such as conventional external irradiation, hormones, and nitrogen mustard.

Two roentgenograms; 1 table.

Disseminated Histiocytosis X (Letterer-Siwe's Disease) Treated Unsuccessfully with Radioactive Colloidal Gold (Au^{198}). A Case Report. Theodore A. Tristan, Antolin Raventos, and Richard H. Chamberlain. *Cancer* 9: 831-836, July-August 1956. (Department of Radiology, Hospital of University of Pennsylvania, Philadelphia 4, Penna.)

The authors report a case of disseminated Letterer-Siwe's disease in a 16-month-old white boy. Because of the theoretical possibility that the abnormal histiocytes might retain the power of active phagocytosis, the patient received a test dose of 2.8 mc of Au^{198} administered intravenously. Subsequently, differential Geiger counts were obtained over involved and uninvolved tissues, and there appeared to be a slight to definite increase in uptake by the involved tissues. The reason for subsequent clinical improvement could not be definitely established, as the patient received both the radioactive gold and dermatologic therapy prior to improvement.

A relapse occurred, and the patient again received radioactive gold, consisting of 7 mc administered intravenously. For two weeks he was watched closely, no other form of therapy being given. His condition de-

teriorated. Local dermatologic therapy was then instituted and the skin improved markedly.

As the patient was in terminal condition as the result of rapidly progressive disease, 14.6 mc of Au^{198} were given intravenously. Biopsies of osteolytic lesions of the skull were obtained, as well as of uninvolved bone, and no definite differential uptake of the radiocolloid was demonstrated.

It is the authors' impression that there was some selective localization of the radioactive colloid, at least early in the disease, but that it was insufficient to offer therapeutic benefit. They believe that this approach to the treatment of Letterer-Siwe's disease may merit further exploration but that, in view of the radiation hazard involved, treatment doses should not be used unless encouraging evidence of concentration of material in the abnormal tissue is found by biopsy after tracer doses.

Seven roentgenograms; 2 photographs; 1 graph.

JAMES E. BAUER, M.D.
University of Missouri

Clinical Aspects of Treatment of Carcinomas of the Gastrointestinal Tract with Isotopes. Josef Becker and Kurt Ernst Scheer. *Strahlentherapie* 100: 184-191, 1956. (In German) (Czerny-Krankenhaus für Strahlenbehandlung der Universität Heidelberg, Heidelberg, Germany)

In spite of the considerable progress of surgery in cancer of the gastrointestinal tract, only a small percentage of the tumors are accessible to radical operation. The majority are still referred to the radiologist for palliative therapy. It was natural that, after the introduction of the radioactive isotopes, various methods of their application were developed, in the hope of obtaining better results. External x-ray therapy combined with the use of isotopes has seemed to offer the greatest improvements.

Promising results have been observed with the use of cobalt pearls for the treatment of carcinomas of the esophagus and cardia. This leads to a rapid improvement in most cases and avoids the tendency to stenosis which is often encountered in external x-ray therapy. In large tumors additional infiltration of the base of the mass with radioactive phosphorus or gold is done through the esophagoscope.

Another type of intracavitary treatment of carcinoma of the stomach—the balloon method—is described in detail. The balloon is introduced through a gastric fistula and filled with a macrosuspension of a radioactive solution.

In inoperable carcinoma of the rectum or sigmoid a colostomy is performed, followed by interstitial implantation of radioactive tantalum, cobalt, or gold, either through the rectoscope or by laparotomy. Rubber balloons, filled with a radioactive macrosuspension, or cobalt molds have also been used in these conditions with favorable results.

Eleven roentgenograms.

HERBERT POLLACK, M.D.
Chicago, Ill.

A Comparison of the Metabolism of Rubidium 86 and Potassium 42 Following Simultaneous Injection into Man. Malcolm P. Tyor and James S. Eldridge. *Am. J. M. Sc.* 232: 186-193, August 1956. (M.P.T., VA Hospital, Durham, N. C.)

Since the short half-life of K^{42} (12.4 hours) has proved

to be a handicap in attempts to study potassium metabolism, it has been suggested that the use of Rb^{86} , with its longer half-life of 19.5 days, may prove valuable in deducing further information concerning potassium metabolism. The two elements have been shown to be similar biologically.

Solutions of K^{42} (as potassium chloride) and Rb^{86} (as rubidium chloride) were simultaneously injected intravenously in 5 patients. Blood and urine samples were then studied for the ratio of Rb^{86} to K^{42} in serial samples collected at intervals ranging from ten minutes to sixty hours after injection. Within individual patients, a constant ratio of Rb^{86} to K^{42} in plasma, red cells, white cells, and urine was maintained throughout a two- to three-day period of observation. The ratio to the injected dose was similar in all fractions except urine, which showed less Rb^{86} and more K^{42} . The ratio of urinary excretion, however, maintained a definite relationship to the ratio of injected isotopes and was similar in all patients studied.

The authors suggest that further information as to K^{42} metabolism may be obtained by parallel studies using Rb^{86} , but caution that the data must be interpreted in the light of the differences in urinary excretion of these two isotopes.

Two charts; 3 tables. JAMES E. BAUER, M.D.
University of Missouri

Rate of Elimination of Labeled Carbon Dioxide from the Body. Douglas R. Drury, Arne N. Wick, and Mary

Carol Almen. *Am. J. Physiol.* **186**: 361-364, August 1956. (Department of Physiology, School of Medicine, University of Southern California, Los Angeles, Calif.)

The authors studied the rate of elimination of labeled carbon dioxide from the body experimentally [though in what animals or in how many they do not state]. In one experiment the rate of elimination of labeled CO_2 was followed during several short periods after the single intravenous injection of a definite amount of radioactive bicarbonate. In the other, the problem was studied by injecting tagged bicarbonate and after a given interval killing the animal and determining the specific activity of the CO_2 of the blood and individual tissues.

When C^{14} -labeled bicarbonate is injected intravenously, about 10 per cent of it is exhaled within thirty seconds by the lungs before it is mixed with body CO_2 . Labeled CO_2 that has escaped elimination by the lungs is mixed with body CO_2 in a complex manner. The CO_2 in those tissues with a high blood flow equilibrates very rapidly with that of blood. Resting muscle and skin need at least five minutes for equilibration with the CO_2 of the blood. Calculations of body CO_2 pool based on the assumption of complete instantaneous equilibrium between blood and tissues are not valid. The manner of elimination of labeled CO_2 produced in metabolism is complex and does not simulate that following intravenous or intraperitoneal injection of labeled bicarbonate.

Four tables.

RADIATION EFFECTS—PROTECTION—EXPERIMENTAL STUDIES

Radioactivity in Man and His Environment. Presidential Address (British Institute of Radiology). F. W. Spiers. *Brit. J. Radiol.* **29**: 409-417, August 1956. (Department of Medical Physics, University of Leeds, Leeds, England)

The radiation dose received naturally by the tissues of the human body arises from external sources, which include terrestrial radioactivity and cosmic rays, and from internal radioactivity acquired from food, water, and air. Each of these factors giving rise to ionizing radiations is analyzed and the individual radioactivity data are used to derive the dose to human gonads and to osteocytes in bone.

The author discusses the contributions from (1) surface rocks and oceans, (2) air, and (3) drinking water and food. The natural radioactivity of the human body is shown to be due largely to radium, mainly from ingested foods, K^{40} , and to a less extent from C^{14} . The external radiation background is due for the most part to the local rock radioactivity. The cosmic radiation dose rate is estimated at 28 mrad/year at sea level. Radiation from thoron and radon add little to the external dose.

The potassium content of the body provides the chief source of internal radiation of the soft tissue. The tissue dose can be calculated to be 20 mrad/year. The energy disposition due to C^{14} is approximately equal to 1 mrad/year. With assumptions regarding atmospheric content and inhalation rate, the dose rate due to inhaled decay products of radon equals 0.16 mrad/year.

The total dose rate to the gonads is then considered. It is seen to be 97 mrad/year, or a total dose to age

thirty years of 2.91 rads. Most of the dose is due, as previously suggested, to cosmic rays (28 mrad), local x-rays (45 mrad), and internal radiation from K^{40} (20 mrad).

The dose to the lungs may be from two to four times that received by the other body tissues because of radiation from inhaled particulate matter carrying the decay products of radon and thorium, in addition to dosage from the external sources of radiation and from K^{40} . The bone tissues receiving the highest dose from natural sources are the osteocytes lying in the regions of bone which incorporate radium. The dose rate from external sources will be practically the same as is calculated for soft tissues, but the K^{40} contribution is less, since the concentration in the bone is about four times less than in muscle. The total dose rate equals 121 rem/year, although the variation from site to site in bone cannot be estimated with assurance.

The author also considers what quantities of acquired radioactive element from natural sources will produce dose rates equal to those already received by body tissue. This is done with Cs^{137} and Sr^{90} . The relationship of a gonad dose of 3 r in a generation to that required to double the human spontaneous mutation rate is uncertain because the radiosensitivity of human genes is unknown. The most recent estimate suggests that the so-called doubling dose is unlikely to be much more than ten times this background dose.

The dose rate to the soft tissue in bone is about 6 rad in fifty years. This is some 2,000 times less than dose rates to osteocytes which have been estimated in cases where small accidental burdens (approximately 0.4 microgram), have been associated with radio-

graphically detectable but not necessarily malignant changes in bone.

The dose rate to the upper respiratory tract and to the lung is of the order of 15 rad in fifty years. This is 100 to 1,000 times less than the order estimated in cases of carcinoma attributable to irradiation of body tissue.

The natural background dose stands nearest, then, in relationship to those doses thought to be genetically significant. Several orders of magnitude lie between the natural dose and those associated with carcinogenesis.

Ten tables.

STEPHEN N. WIENER, M.D.
Mt. Sinai Hospital, Cleveland, Ohio

Fatal Pulmonary Insufficiency Due to Radiation Effect upon the Lung. Daniel J. Stone, Miles J. Schwartz, and Robert A. Green. *Am. J. Med.* 21: 211-226, August 1956. (VA Hospital, Bronx, N. Y.)

Five cases of radiation pneumonitis and fibrosis leading to severe pulmonary insufficiency are reported. In these cases x-ray therapy had been administered for malignant disease of the lung or mediastinum (Hodgkin's disease 2, epidermoid carcinoma of lung 1, testicular embryonal carcinoma 1, and seminoma 1). The radiation data are presented in tabular form. Correlated clinical, functional, and pathologic findings indicate that impaired diffusion across the alveolar-capillary membrane played an important role in the functional abnormality in each instance. The roentgen changes suggestive of pulmonary fibrosis corresponded quite well with the portal areas of irradiation. Both lungs were involved in all patients, either because of bilateral radiation or the use of lateral or oblique multidirectional portals. The microscopic findings in all areas of the lung indicated that the changes were radiation-induced and not significantly related to the pulmonary disease suffered by the patients.

Steroid therapy, utilized in 4 patients, failed to alter the course of the acute syndrome.

Most radiologists suggest that the appearance of radiation fibrosis depends, at least in part, upon the amount of radiation given and the volume of tissue exposed, although other factors such as age, infection, and the presence of neoplastic disease or pulmonary emphysema may influence the pathologic changes. From the authors' observations, it would seem clear that the total dose delivered to both lungs (during one or more courses of treatment) and the brevity of the period in which a significant volume of lung tissue is irradiated are probably significant, if they are not indeed the two most important single factors. In 2 of the cases recorded here the fatal syndrome occurred after 4,100 and 3,200 r, respectively, administered in a relatively short period. In another case 6,000 r was given over a period of forty days before pulmonary fibrosis occurred. It does not seem unreasonable, therefore, to relate the individual development of pulmonary fibrosis to the volume of lung exposed, the total depth radiation, and finally the rapidity with which this total depth radiation is delivered. It is suggested that cumulative effects of radiation may occur. The authors speculate that in 2 of their cases previous courses of therapy produced some pathologic changes in the lungs, without clinical manifestations, and it was only after multiple courses that the clinical picture of radiation reaction developed. They are of the opinion that such reactions were uncommon in the past because available techniques did not permit as

extensive depth irradiation as has now become possible.

Seventeen roentgenograms; 7 photomicrographs; 2 tables.

The Pathological Anatomy of the Changes Involving the Pulmonary Parenchyma after High Doses of X-Rays. Harold Henzi. *Strahlentherapie* 100: 275-290, 1956. (In German) (Pathologisches Institut der Universität Bern, Bern, Switzerland)

The author discusses nine patients in whom changes of the pulmonary tissue were observed, following large doses of x-ray irradiation for treatment of carcinoma of the esophagus, breast, bronchi, and Hodgkin's disease. These pulmonary changes he compares with those observed in virus pneumonia. He is of the opinion that excessive radiation directed to the lungs produces damage of the capillary walls with extravasation of liquid blood constituents and imbibition by the tissue. Furthermore, the local macrophages become increased in number and enlarged, and there is swelling of the collagenic substance.

Following these acute changes there is a tendency toward fibrosis, often leading to fibrous interstitial induration of the pulmonary parenchyma. The similarity of this process to interstitial virus pneumonitis and whether it should be classified as inflammation in the classical sense are discussed in detail.

This condition rarely leads to death, although a secondary bronchopneumonia may be fatal.

Seven photomicrographs.

HERBERT POLLACK, M.D.
Chicago, Ill.

Osteogenic Sarcoma of Phalanx After Chronic Roentgen-Ray Irradiation. Robert E. Carroll, John T. Godwin, and William L. Watson. *Cancer* 9: 753-755, July-August 1956. (Memorial Center for Cancer and Allied Diseases, New York, N. Y.)

The authors present the clinical history, with a description of the pathological and roentgen findings, of a tumor of the distal phalanx of the thumb of a dentist who for many years had been intermittently exposed to roentgen irradiation while holding dental films in place during examination of his patients. The series of events in this case makes it reasonable to assume that this was an example of post-irradiation osteogenic sarcoma.

Two roentgenograms; 4 photomicrographs.

JAMES E. BAUER, M.D.
University of Missouri

Shoe-Fitting X-Ray Fluoroscopes. Radiation Measurements and Hazards. E. D. Dyson. *Brit. M. J.* 2: 269-272, Aug. 4, 1956. (Medical Department, U.K.A.E.A., Risley, England)

In setting up criteria for judging the effects of shoe-fitting x-ray fluoroscopes, the author quotes the International Commission on Radiological Protection which recommends that the large-population maximum permissible dose to extremities, such as the feet, be 0.15 r a week or about 2 r per three months. A recent type of British machine gave a dose rate in shoe-fitting of about 4 r a minute. Thus the permissible 2 r per quarter year would allow three exposures of ten seconds each, or two exposures of fifteen seconds, and so on, in each three-month period.

Special problems in the use of these fluoroscopes con-

cern the hazards to shop personnel; the larger doses going to infants and children by reason of their needing new shoes perhaps as often as every three months; and the increase in background radiation for the population as a whole. In the case of children there arises the question of irradiation to the immature epiphyses, with possible effects on growth.

In attempting to assay the dosage to shop assistants, film badges were issued to some personnel who wore them for a week. Only a minimum radiation dose (less than 10 r) was measured on these films. American studies on 77 salesmen had shown that only 2 received a dose around the maximum permissible level, and that at foot level (one of the film badges was carried in the cuff).

If the population dose from shoe-fitting fluoroscopes is compared to that received from background radiation, it is found that the shoe-fitting dose rate is of the order of only 1/1,000 of the natural background dose rate, and the genetic aspect is therefore negligible. Nevertheless, the author considers control measures essential and proposes that dosage to customers' feet could be limited by specifying a maximum dose rate in the useful beam, perhaps also with limits on the kilovoltage and current of the x-ray tube. The specification of some minimum filtration is desirable, and some form of timing device may be necessary to limit the length of each individual exposure. If viewing were done by a special shop assistant who was kept partly dark-adapted, a less bright fluorescent image could be used and radiation doses reduced. The minimum screening of the x-ray equipment and viewing hood could be specified or a maximum permissible dosage rate fixed, to be measured against the outside of the equipment. The effect of scattered radiation coming from the foot opening of the machine could be minimized by pointing the opening toward the wall, away from the center of the shop.

Three drawings; 2 tables.

Some Effects of Ionizing Radiation on the Physiology of the Gastrointestinal Tract: A Review. Robert A. Conard. *Radiation Res.* 5: 167-188, August 1956. (Brookhaven National Laboratory, Upton, L. I., N. Y.)

Gastrointestinal symptomatology and functional disturbances attributable to various doses of ionizing radiation are discussed. On the basis of histologic and weight changes, the small intestine has been shown to be the most sensitive component of the gastrointestinal tract. Loss of body weight following irradiation is probably related to functional disturbances in this system. Motility of the small intestine is increased during and immediately after irradiation but becomes depressed during the next three or four days. Data are presented which indicate that such changes are related to neurohumoral imbalance of the autonomic nervous system of the gut. Some investigators report that absorption from the intestine is impaired by radiation, while others feel that such impairment is a reflection of the altered motility.

Supralethal doses of radiation produce death in three to four days, and studies indicate that such mortality is closely correlated with dehydration and electrolyte imbalance associated with loss of fluid from vomiting and diarrhea.

Efforts to modify the gastrointestinal effects of radiation are reviewed. Favorable effects have been noted in the following experiments: (1) shielding the intestine or abdomen during irradiation; (2) pre-irradiation ad-

ministration of sulphhydryl compounds and PAPP (β -aminopropiophenone); (3) induction of anoxia during irradiation; (4) use of antibiotics provided the radiation dose is not too high; (5) correction of fluid and electrolyte imbalance. Unimpressive or unfavorable results were reported from (1) administration of bone marrow or spleen homogenates, or by shielding the spleen during irradiation; (2) autonomic drugs; (3) antihistaminic drugs.

The possible mechanisms of radiation effects on the gastrointestinal tract are discussed.

Twelve figures.

AUTHOR'S ABSTRACT

Radiation Protection for the General Practitioner. Lauriston S. Taylor. *South. M. J.* 49: 826-831, August 1956. (Atomic and Radiation Physics Division, National Bureau of Standards, Washington, D. C.)

Radiation protection in the case of the general practitioner presents a problem distinct from that involved in the practice of radiology as a specialty. In the first place, there are perhaps ten times as many x-ray units in the hands of practicing physicians as are in use by accredited radiologists. Second, since his use of x-rays is usually secondary to the employment of other diagnostic procedures, the general practitioner only rarely acquires the highly specialized background in radiologic physics necessary to a full appreciation of the technical aspects of protection. In the third place, the examinations are frequently conducted in private homes and apartments or office buildings not designed with this purpose in mind. Finally, because, for the most part x-ray examinations are considered secondary to other procedures, there is increasing temptation to economize on protective measures.

The author discusses the exposure of the physician himself, his office staff, and the neighbors, and concludes that the disadvantages under which the average general practitioner has to use x-rays as a diagnostic tool lead him to accept more, rather than less, radiation exposure per examination as compared with that in a specialized x-ray clinic. He is saved from more serious complications mainly because his daily work load is less. Nevertheless, he should make every effort to reduce radiation exposure to his patients, his neighbors, and himself to the absolute minimum. To this end he should obtain expert help.

Two tables.

Photographic Badges for the Estimation of the Quality of X and Gamma Radiation. B. W. Soole. *Brit. J. Radiol.* 29: 450-454, August 1956. (Admiralty Research Laboratory, Teddington, Middlesex, England)

A review of the literature is given for forward-scattered and back-scattered electrons in relation to atomic number of the scattering material and energy of the incident radiation. The straightforward increase in back-scattered electron emission with radiation energy and its independence of the thickness of the scatterer (after a certain minimum value) led to the choice of the following method of determination of radiation energy.

A ten-step wedge of fine tissue paper was placed above a strip of lead foil as scattering material and x-ray film was placed above the wedge. The excess of blackening of the film above the unfiltered lead over background blackening (film only) was called 100 per cent. The net blackening opposite the various steps of

the wedge was expressed as a percentage of this. These figures subtracted from 100 then represented the "electron-stopping power" of the paper electron filters. A graph of the stopping power in per cent against mg./cm.² of filter for three qualities of radiation (h.v.l. 1.4 mm. Cu, 4.5 mm. Cu, and CO⁶⁰) showed clearly separate curves, and a film exposed to one of the three qualities of radiation could be easily identified. The mathematical relationship between density and electron-stopping power as defined above is given in an appendix.

Five illustrations. LUCILLE DUSAULT, M.S.
The Henry Ford Hospital, Detroit, Mich.

Corticotropin (ACTH) Gel in Treatment of Irradiation Enterocolitis. Report of Two Cases. George E. MacDonald and Lyman H. Hoyt. J.A.M.A. 161:1381-1383, Aug. 4, 1956. (New England Deaconess Hospital, Boston, Mass.)

The authors report 2 cases of enterocolitis which occurred following therapeutic irradiation of the sacrum and pelvis for secondary neoplasm. Because of the beneficial effects of corticotropin in the treatment of certain types of enterocolitis, the authors used corticotropin gel by the intramuscular route in the treatment of these 2 cases of irradiation enterocolitis after standard methods of control had failed. In both patients there was rapid control of the signs and symptoms, a definite increase in appetite, and improvement in mental outlook. One of the patients was still alive at the time of the report.

JAMES E. BAUER, M.D.
University of Missouri

The Effect of Single Doses of Roentgen Radiation on Experimentally Induced Gliomas: with a Critical Review of the Effects of Roentgen Radiation on Gliomas in Man. Martin G. Netsky, Jerome Shapiro, Marilyn Hoffman, B. Corsentino, J. R. Freid, and H. M. Zimmerman. Am. J. Roentgenol. 76: 351-366, August 1956. (M. G. N., Bowman Gray School of Medicine, Winston-Salem, N. C.)

The authors first review the difficulties in determining the value of roentgen therapy in human gliomas and then present observations on the effects of single doses of roentgen radiation, varying from 200 to 5,000 r, on ependymoblastomas transplanted subcutaneously in mice.

Histologic changes were found to be similar at all doses, though varying widely in extent and severity, being more marked and widespread at 3,000 and 5,000 r. Measurement of tumor growth rate showed little effect of small doses (200 and 400 r); transient depression by intermediate doses (1,200 r); and either destruction or diphasic growth (*i.e.*, regrowth after an initial inhibition) at high doses (3,000 and 5,000 r). At times regrowth following the initial period of depression was rapid. A hypothesis suggesting release of a growth-promoting substance by the heavily irradiated cells, acting on the slightly irradiated or unirradiated cells, is proposed as an explanation for this phenomenon.

Experiments on isolated tumors (*i.e.*, not transplanted into living animals) showed that complete destruction of the tumor was possible with doses of 3,000 r. The authors feel that these experiments tend to minimize the role of blood vessels and the tumor bed in the mechanism of roentgen-ray damage to tumors.

Ten photomicrographs; 1 photograph; 7 charts.

WILLIAM S. HARWELL, M.D.
Shreveport, La.

The Use of Small Laboratory Animals in Medical Radiation Biology. IV. Correlation of Physical Factors with the Biological Effect Produced by Total-Body Irradiation of Guinea Pigs. Friedrich Ellinger, Jasper E. Morgan, and Ellsworth B. Cook, with the assistance of W. A. Sterling. Cancer 9: 768-772, July-August 1956. (Naval Medical Research Institute, Bethesda, Md.)

The authors report a study of the effects of whole-body irradiation in guinea-pigs which indicates that these animals can be utilized in lethal-dose experiments with an accuracy equal to that for mice.

The LD 50 in fourteen days was taken as the criterion of response, and higher values were obtained for this end-point than had been established previously in guinea-pigs. This discrepancy the authors explain by the fact that a highly inbred strain of animals was used in this experiment, while hybrid animals had been used for the earlier study, it having been shown by others that highly inbred species are more radioresistant than their hybrid counterparts. It was found that guinea-pigs of quite different weights can be used without compromising reproducibility of data, provided the groups are weight-matched. Guinea-pigs were also found to show a definite position effect, in comparison with mice, for the lethal action of roentgen rays, which the authors feel was to be expected in accordance with the size of the animals. Irradiation in a lateral position resulted in a higher mortality than either anteroposterior or postero-anterior exposures.

Five graphs; 2 tables. JAMES E. BAUER, M.D.
University of Missouri

Early Changes of Bone of Adult Guinea Pigs after Roentgen Irradiation. Rudolph Birkner, Julius Frey, and Karl-Heinz Ueberschär. Strahlentherapie 100: 574-590, 1956. (In German) (Stadt. Krankenhaus Moabit, Berlin, Germany)

To determine the effects of irradiation on bone, the authors irradiated the femurs of guinea-pigs with single massive doses of 5,000 r at 110 kv, 0.4 mm. Cu h.v.l., a target-skin distance of 31.3 cm., 37 r/min. Special attention was given to the effects on the cellular and vascular elements.

After three days, the osteocytes were seen to be involved in a necrotic process, followed by complete osteonecrosis. The blood vessels did not show any degenerative signs at this time. The reaction in the periosteum and in the periosteal osteoblasts appeared about two weeks later. Alterations of the blood vessels were evident in the fourth week after irradiation. The main cause of the osteonecrosis is said to be a direct radiation effect on the osteocytes. The subsequent vascular damage is held responsible for the ultimate fate of the necrotic bone.

Nineteen photomicrographs; 1 photograph; 1 drawing. LEWIS L. HAAS, M.D.
University of Illinois

Alkaline Phosphatase Activity in Various Mouse Tissues Following Total Body X-Irradiation. Joseph L. Mollura and Anna Goldfeder, with the assistance of Grace E. Clarke. Am. J. Physiol. 186: 224-226, August 1956. (Cancer Research Laboratory, Department of Hospitals, City of New York, New York, N. Y.)

The distribution of alkaline phosphatase in various mouse tissues (duodenum, spleen, liver, kidney, and

mammary glands) and the effects of ionizing radiation on the activity and distribution of this enzyme were studied by the use of the Gomori method. A total-body dose of 700 r, known to kill 50 per cent of the mice of the C₃BL/6 strain in about nine days, as well as doses up to 10,000 r, failed to produce any apparent change in alkaline phosphatase activity of the various tissues, which were removed from two hours to fourteen days after exposure. On the basis of these observations it may be inferred that alkaline phosphatase is not involved in cytological damage induced by ionizing radiation.

Two photomicrographs.

AUTHORS' ABSTRACT

Influence of Temperature Stress on Uptake of P³² in the Rat. John A. Sealander, Jr. *Am. J. Physiol.* 186: 227-230, August 1956. (Zoology Department, University of Arkansas, Fayetteville, Ark.)

Different groups of rats were individually exposed to cold ($2^{\circ} \pm 1.5^{\circ}$ C.) and hot ($35^{\circ} \pm 1.5^{\circ}$ C.) environments for periods of ten, twenty-three, and twenty-nine or thirty days. After each period of exposure a group of rats was dosed with tracer phosphorus, each animal receiving an intraperitoneal injection of about $20 \mu\text{C}$ P³². They were then returned to the hot or cold environment and were killed after forty-eight hours.

Measurements of P³² and total P in the various tissues showed that the percentage of the injected dose in liver, bone, and adrenal tissue was significantly higher in heat-stressed as compared with cold-stressed rats. The percentage of the injected dose in brown fat was significantly higher in cold-stressed rats. No significant differences were apparent for body fat.

Observed differences in relative specific activity in different tissues from heat- and cold-stressed rats were interpreted primarily on a dilution basis. Evidence of acclimation to heat and cold after exposure periods of twenty to thirty days was provided by the reappearance of visible fat depots, recovery of body weight, and adrenal weight changes. These findings suggest that the thermal environment of the animal must be carefully considered in any interpretation of tracer isotope studies concerned with metabolic processes.

Two charts; one table.

Transplantability of a Canine Thyroid Carcinoma Through Thirty Generations in Mixed-Breed Puppies. M. W. Allam, L. S. Lombard, E. L. Stubbs, and J. F.

Shirer. *J. Nat. Cancer Inst.* 17: 123-129, August 1956. (School of Veterinary Medicine, University of Pennsylvania, Philadelphia, Penna.)

A spontaneous canine thyroid carcinoma was serially transplanted in mixed-breed canine hosts. Three hundred seventy-two puppies were x-irradiated at a level of 150 to 300 r. Three hundred twenty-four lived seven days or longer and in 278, or 85.8 per cent of these, grossly recognizable tumors developed subsequent to inoculation with tumor cells from the seventh to the thirteenth transplant series. Twenty-six dogs pretreated with nitrogen mustard received inoculations of cells in the subcutis of the flank, and 69.2 per cent showed transplant growth. Of 64 dogs injected with neoplastic cells without pretreatment, 60.9 per cent had transplant growths in various sites.

In advanced generations, the tumor tissue was histologically similar to that of the first six serial passages previously reported (*Cancer Res.* 15: 734, 1954). Metastases occurred occasionally in the x-irradiated and untreated groups, but not at all in the nitrogen mustard series. Regional lymph nodes were the most common site of involvement. Determination of complete regression could be made only in the subcutaneous area. Regressions occurred occasionally to frequently in all groups.

Four illustrations; 1 table.

Temperature Dependence of Bacterial Inactivation by X-Rays. G. E. Stapleton and C. W. Edington. *Radiation Res.* 5: 39-45, July 1956. (Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tenn.)

The inactivation of *E. coli* B/r was investigated as a function of the temperature during x-irradiation for oxygen-saturated and oxygen-depleted suspensions. Oxygen-saturated suspensions showed a significant change in sensitivity at subfreezing temperatures and a discontinuous change at the freezing point. In the absence of oxygen, however, no significant change in sensitivity occurred with a decreasing temperature below the freezing point. These findings suggest that at a temperature below the range investigated no oxygen effect should be demonstrable. The findings reported are consistent with the hypothesis that subfreezing temperatures protect against inactivation of bacteria by interference with production of the toxic agent as well as its diffusion to the sensitive site within the cell.

One figure; 3 tables.

INDEX TO VOLUME 68

A

ABBATT, JOHN D., FARRAN, HELEN E. A., and GREENE, RAYMOND: Acute myeloid leukemia after radioactive-iodine therapy (ab), April, 628

ABDOMEN

See also under names of abdominal organs and structures, as Aorta; Kidneys; Liver; etc.

—reconstruction of entire anterior abdominal wall in presence of posttraumatic changes (ab), James E. Pridgen and Charles W. Tension, May, 792

acute conditions

—acute intermittent porphyria with acute abdominal findings and palpable mass (ab), Wesley Furste and Perry R. Ayres, Feb., 302

—intravenous cholecyst-cholangiography in emergency abdominal diagnosis (ab), Robert S. Sparkman and Paul R. Ellis, March, 450

—unusual causes of free intraperitoneal air in acute conditions (ab), Robert D. Spensley et al., Jan., 131

—blood supply. See Aneurysm, aortic; Aorta; Venae Cavae roentgenography. See Pneumography; other subheads under Abdomen

—surgery. See Biliary Tract; Peptic Ulcer; etc.

tumors

—anterior displacement of descending duodenum as aid in diagnosis of retroperitoneal tumor: roentgenographic sign of possible significance in some cases of enlargement of right adrenal gland (ab), Emil J. Ganem et al., Jan., 132

—roentgen examination of inferior vena cava in retroperitoneal expanding processes (ab), C. G. Helander and Å. Lindbom, Feb., 288

—simple approach to roentgen diagnosis of tumors in infants and children (ab), Charles M. Nice, Jr. et al., March, 459

wounds and injuries

—trauma to abdominal and retroperitoneal viscera as it concerns radiologist (ab), J. Cash King, April, 617

ABELANET, RENÉ. See DELARUE, JACQUES

ABNORMALITIES. See under organs and regions, as Heart, abnormalities

ABRAMOV, A., SCHORR, S., and WOLMAN, M.: Generalized xanthomatosis with calcified adrenals (ab), Jan., 112

ABRAMS, HERBERT L.: Radiologic aspects of operable heart disease. III. The hazards of retrograde thoracic aortography. A survey, June, 812

ACETABULUM

See also Hip

—mongolism (mongoloid deficiency) during early infancy—some newly recognized diagnostic changes in pelvic bones (ab), John Caffey and Steven Ross, March, 456

—Otto pelvis: 2 cases associated with labor (ab), W. H. Muller, April, 614

ACETRIZOATE. See Pyelography

ACHALASIA. See Stomach, cardiospasm

ACIDS

—biosynthesis of fatty acids in liver and intestine of intact normal, fasted and x-irradiated rats (ab), John G. Coniglio et al., April, 635

ACKER, EARLE D. See SHARP, ANDREW G.

ACKERMAN, LAUREN V. See CUNNINGHAM, JAMES B.

—See SEAMAN, WILLIAM B.

ACKERMANN, WOLFGANG: Vertebral trephine biopsy (ab), March, 455

ACLASIS. See Epiphyse

ACTINIUM. See Radioactivity, radioactinium

ACTIS-DATO, A., ANGELINO, P. F., and BRUSCA, A.: An angiopulmographic study of the lesser circulation in mitral stenosis (ab), May, 768

ADAMS, GAIL D., and BALKWELL, WILLIAM R.: Advances toward a stable sensitive iron dosimeter, Jan., 101

ADAMS, JOHN D., and NOEL, R. D.: Operative cholangiograms. A critical review of their value (ab), Jan., 135

ADENOMA. See Bronchi; Lungs, cancer; Parathyroid

ADLER, E. See SCHORR, S.

ADLER, HOWARD. See KAPLAN, GUSTAVE

—See POPPEL, MAXWELL H.

ADOLESCENCE

—arterioenteric obstruction of duodenum in adult life and adolescence (ab), Erik de F. Licht, April, 608

—tuberculous coin lesion—a roentgenological symptom (observations in children and adolescents) (ab), H. D. Renovanz, March, 438

ADRENALS

—roentgenological appearance of normal glands (ab), Richard H. Harrison, III, and Leonard C. Doubleday, June, 505

calcification

—generalized xanthomatosis with calcified adrenals (ab), A. Abramov et al., Jan., 142

cancer

—anterior displacement of descending duodenum as aid in diagnosis of retroperitoneal tumor: roentgenographic sign

of possible significance in some cases of enlargement of right adrenal gland (ab), Emil J. Ganem et al., Jan., 132

—large carcinoma; case, W. C. Strittmatter, C. H. Brown and H. A. Tretbar, Feb., 231

tumors

—danger of aortography in localization of pheochromocytoma (ab), Nathan J. Saltz et al., May, 785

ADRENOCORTICAL PREPARATIONS

—controlled study of cortisone therapy for headache after pneumoencephalography (ab), Orceneth A. Fly, Jr. et al., April, 600

—cortisone versus x-ray in treatment of subacute thyroiditis: 4 cases (ab), Lawrence Taylor, April, 622

—effect of radiophosphorus and cortisone on transplanted mammary adenocarcinomas in susceptible and resistant mice (ab), Norman E. Boucher, Jr. et al., May, 789

—treatment of low-back and sciatic pain by injection of hydrocortisone into degenerated intervertebral disks (ab), Henry L. Feffer, April, 612

ADRENOCORTICOTROPIC HORMONE

—corticotropin (ACTH) gel in treatment of irradiation enterocolitis: 2 cases (ab), George E. MacDonald and Lyman H. Hoyt, June, 917

AGE

—incidence of spina bifida occulta in relation to age (ab), Wataru W. Sutow and Arthur W. Pryde, Jan., 139

AHUMADA, JUAN C., NOGUÉS, ARMANDO E., and DONOVAN, CORNELIO: Hystero-graphy in the diagnosis of dead and retained human ovum (ab), April, 614

ALBRIGHT, C. PETER. See BROWN, CHARLES H.

ALBUMIN. See Blood, proteins

ALDRIDGE, NOEL H.: Cholecystography and cholangiography: a review of present methods of examination (ab), April, 609

Combined intravenous cholecystography and pyelography (ab), Jan., 143

ALEXANDER, EBBE, Jr. See FOWLER, FRED D.

ALIMENTARY TRACT. See Gastrointestinal Tract; Intestines; Stomach; etc.

ALKAPTONURIA

—alkaptonuric arthritis (ab), A. J. Harrold, March, 452

ALLAM, M. W., LOMBARD, L. S., STUBBS, E. L., and SHIRER, J. F.: Transplantability of a canine thyroid carcinoma through thirty generations in mixed-breed puppies (ab), June, 918

ALLEN, R. F. See REIQUAM, C. W.

ALLERGY

—effect of intravenous Benadryl in allaying allergic manifestations of 70 per cent Urokon (ab), Jack Lapidus and Robert E. Boyd, April, 617

—reactions due to intravenous Urokon (ab), Vernon H. Youngblood et al., April, 617

ALMEN, MARY CAROL. See DRURY, DOUGLAS R.

D'ALOTTO, VICTORINO: Radiology of the pharyngo-esophageal region; Plummer-Vinson syndrome (ab), Feb., 289

ALUMINUM AND ALUMINUM COMPOUNDS

—differential diagnosis between aluminum lung and Boeck's sarcoid; correction of article by K. H. Ehrecke (ab), F. Leicher, March, 438

AMATUZIO, D. S., HAGEN, P. S., and EVANS, R. L.: Incorporation of N¹⁵-labeled glycine in the plasma protein, plasma phospholipids, blood non-protein nitrogen, and splenic tissue in man (ab), March, 472

AMBERG, JOHN R., and RIGLER, LEO G.: Results of surgery in carcinoma of the stomach discovered by periodic roentgen examination (ab), April, 607

AMERICAN BOARD OF RADIOLOGY

—certification, Feb., 269

—examination for certification in nuclear medicine, Jan., 108

—examinations, June, 872

AMERICAN COLLEGE OF RADIOLOGY

—annual meeting, Jan., 108; Feb., 269

AMES, ROSE. See CAFFEY, JOHN

AMUNDSEN, A. K., AMUNDSEN, P., and MÜLLER, O.: Blood pressure and heart rate during angiocardiology, abdominal aortography, and arteriography of the lower extremities (ab), April, 604

AMUNDSEN, P., and HOLTER, I.: Cardiovascular changes in dystrophia mesodermalis congenita Marfan (ab), March, 441

—See AMUNDSEN, A. K.

—and SØRENSEN, EDVIN: Angiocardiography in intrathoracic tumours with particular reference to the question of operability (ab), Jan., 126

AMYES, EDWIN W., and ANDERSON, FRANK M.: Fracture of the odontoid process. Report of sixty-three cases (ab), Feb., 279

AMYLOIDOSIS

—primary amyloidosis; case of gastric involvement only (ab), Anthony D. Intriere and Charles H. Brown, March, 447

ANDERSCH, H. See SCHRÖDER, G.

- ANDERSON, EMORY H.** See **SHARP, ANDREW G.**
- ANDERSON, ERNEST C., SCHUCH, ROBERT M., PER-RINGS, JAMES D., and LANGHAM, WRIGHT H.:**
The Los Alamos human counter (ab), March, 473
- ANDERSON, FRANK M.** See **AMYES, EDWIN W.**
- ANDERSON, HJALMAR, Jr.** See **CROSBY, WILLIAM H.**
- ANDERSON, WILLIAM.** See **SAMET, PHILIP**
- ANEMIA**
- aplastic**
- secondary to intravenous therapy with radiogold; case (ab), Harold M. Schoolman and Steven O. Schwartz, Jan., 152
- pernicious**
- studies in urinary excretion of vitamin B₁₂Co⁶⁰ in pernicious anemia for determining effective dosage of intrinsic factor concentrates (ab), William R. Best et al, March, 471
 - time pattern of vitamin B₁₂Co⁶⁰ urinary excretion in man after oral administration and parenteral "flushing" (ab), William R. Best et al, March, 472
- sickle-cell**
- bone infarcts in sickle-cell anemia, Caroline W. Rowe and Mary E. Haggard, May, 661
 - roentgenographically demonstrable splenic deposits in sickle-cell anemia (ab), George Jacobson and Sidney D. Zucherman, June, 905
- ANESTHESIA**
- infectious spondylitis following damage to anterior longitudinal ligament (contribution to spondylitis following paravertebral anesthesia) (ab), W. Forstmann, May, 783
- ANEURYSM**
- aneurysmal bone cyst (ab), Miguel Cruz and Bradley L. Coley, May, 777
 - aneurysmal bone cyst: its roentgen diagnosis, Robert S. Sherman and Kenneth Y. Soong, Jan., 54
- aortic**
- angiocardiology in diagnosis of sacular aneurysm of abdominal aorta; case (ab), Israel Steinberg and Nathaniel Finby, June, 892
 - antemortem diagnosis of syphilitic aneurysm of aortic sinuses; 9 cases (ab), Charles W. Merten et al, Jan., 129
 - clinical manifestations of unperforated aortic sinus aneurysm (ab), Israel Steinberg and Nathaniel Finby, May, 770
 - significance of aortography for diagnosis of abdominal aneurysms (ab), G. Aurig and H. Radke, April, 605
- arteriovenous.** See **Fistula, arteriovenous**
- cerebral**
- cerebral angiographic studies following surgical treatment of intracranial aneurysms; angiographic evaluation of results (ab), Lester A. Mount and Juan M. Taveras, June, 882
 - surgical treatment of intracranial aneurysms; results in angiographically located lesions (ab), Wallace B. Hamby, Feb., 278
- mediastinal**
- bi-axial roentgenkymography: aid in differential diagnosis of solid mediastinal tumor and aneurysm (ab), Martin Schneider and Jorge Ceballos, Feb., 286
- mesenteric**
- radiology of aneurysms of root of superior mesenteric artery; 2 cases (ab), Gastone Peruzzi and Cesare Ruffato, March, 445
- ophthalmic**
- ophthalmic artery aneurysm, Ralph R. Goldin and Maurice L. Silver, May, 727
- renal**
- aneurysm of renal artery (ab), Richard S. Silvis et al, Jan., 142
- splenic**
- splenic artery aneurysms; 17 cases showing calcification on plain roentgenograms, Gordon J. Culver and Herbert S. Pirson, Feb., 217
- vena caval**
- congenital aneurysm of superior vena cava (ab), G. H. Lawrence and T. H. Burford, Feb., 287
- ANGELINO, P. F.** See **ACTIS-DATO, A.**
- ANGIOCARDIOGRAPHY.** See **Cardiovascular System; Heart; Mitral Valve; Thrombosis**
- ANGIOCARDIOPNEUMOGRAPHY.** See **Blood Vessels**
- ANGIOGRAPHY.** See **Aneurysm; Blood Vessels; Brain, blood supply; Fistula, arteriovenous; Hydronephrosis**
- ANGIOMATOSIS.** See **Tumors, angioma**
- ANGIOPNEUMOGRAPHY.** See **Lungs, blood supply**
- ANGIOSARCOMA.** See **Sarcoma, angiosarcoma**
- ANKLE**
- osteochondritis dissecans; case simulating fracture of talus (ab), Bruce M. Cameron, May, 784
- ANTHONY, D. S., CAMPBELL, J. E., HAGEE, G. R., and ROBAJDEK, E. S.:** Analysis of mixtures of radioactive isotopes by γ -ray measurements. Application of the method to Ac²²⁷, Th²³², and Ra²²⁶ (ab), March, 473
- ANTIGENS.** See **Histoplasmin and Histoplasmosis**
- ANTITOXINS**
- correlation of early radiation changes in lymphatic tissues with antitoxin producing ability (ab), William L. Williams et al, April, 636
- ANTON, JOSEPH I.** See **RABINOVITCH, JACOB**
- ANVIL FRACTURE.** See **Spine**
- AORTA**
- See also **Aneurysm**
 - congenital aortic stenosis: clinical aspects and surgical treatment (ab), Daniel F. Downing, June, 892
 - congenital intralobar sequestration with anomalous artery from aorta (ab), Vidar Jensen and Aage Wolff, March, 437
 - discussion on clinical and radiological aspects of diseases of major arteries (ab), H. H. G. Eastcott et al, June, 891
 - systolic expansion or aorto-diastolic displacement: a roentgenkymographic study of left atrial movements in mitral cardiopathy (ab), F. Dalith, Jan., 128
- aneurysm.** See **Aneurysm**
- calcification.** See **Aorta, syphilis**
- roentgenography**
- acute renal failure following translumbar aortography (ab), Owen C. Berg, May, 784
 - blood pressure and heart rate during angiocardiology, abdominal aortography, and arteriography of lower extremities (ab), A. K. Amundsen et al, April, 604
 - contrast medium injury to spinal cord produced by aortography; pathologic anatomy of experimental lesion (ab), G. Margolis et al, May, 770
 - danger of aortography in localization of pheochromocytoma (ab), Nathan J. Saltz et al, May, 785
 - importance of translumbar aortogram and peripheral arteriogram in management of vascular disease (ab), Andrew G. Sharf et al, May, 768
 - new radiologic methods in gynecology: aortography and pelvic arteriography (ab), L. Rossi and B. Maggipinto, Feb., 299
 - paraplegia secondary to abdominal aortography (ab), Joseph G. McCormack, April, 605
 - pre-operative diagnosis of sequestration of lung by aortography (ab), Leo J. Kenney and William R. Eyer, Feb., 281
 - radiologic aspects of operable heart disease. III. Hazards of retrograde thoracic aortography: survey, Herbert L. Abrams, June, 812
 - review of complications of translumbar aortography (ab), John G. McAfee and James K. V. Willson, March, 443
 - serious complications associated with newer diagnostic methods in urology (retroperitoneal pneumography and aortography) (ab), William Baurys, March, 459
 - survey of complications of abdominal aortography, John G. McAfee, June, 825
 - transcarotid aortography (ab), Patrick Crawford et al, May, 768
- syphilis**
- calcification of aorta as aid to diagnosis of syphilis (ab), J. Sydney McCann and D. C. Porter, Feb., 288
 - outcome of uncomplicated syphilitic aortitis (ab), R. E. Irvine, Feb., 288
- AORTIC SINUS.** See **Aneurysm, aortic**
- AORTIC VALVE**
- rheumatoid spondylitis and aortic insufficiency (ab), Donald P. Schilder et al, May, 781
 - transventricular and aortic angiocardiology and physiologic studies in dogs with experimental mitral and aortic insufficiency (ab), Robert J. Wilder et al, May, 771
- AORTITIS.** See **Aorta, syphilis**
- APPARATUS.** See **Roentgen Rays, apparatus**
- APPENDIX**
- See also **Fistula, uretero-appendicular**
 - diverticula; case, Asa B. Friedmann, Jan., 86
 - significance of calcified appendiceal enterolith, Boyer M. Brady and David S. Carroll, May, 648
- AQUEDUCT OF SYLVII**
- vertebral angiography in diagnosis of hydrocephalus and differentiation between stenosis of aqueduct and cerebellar tumor (ab), F. Olov Lofgren, May, 757
- AQUEOUS HUMOR.** See **Eyes**
- ARANGO, ORIO, and MARMOLEJO, AUGUSTO:** Internal biliary fistulas (ab), Feb., 294
- ARCE G., ENRIQUE.** See **CELIS, ALEJANDRO**
- ARCOMANO, JOSEPH.** See **SCHLUGER, JOSEPH**
- ARDRA, G. M., and KEMP, F. H.:** Radiologic investigation of pharyngeal and laryngeal palsy (ab), May, 761
- ARENDT, JULIAN, and ZGODA, ADAM:** Heterotropic excretion of intravenously injected contrast media, Feb., 238
- ARGENTAFFINOMA.** See **Tumors, argentaffinoma**
- ARIEL, IRVING M.:** Treatment of primary and metastatic cancer of the liver (ab), March, 464
- ARMILLIFER.** See **Porocephalosis**
- ARTERIES**
- See also **Aneurysm; Aorta; Arteriosclerosis; Cardiovascular System; Lungs, etc.**
 - congenital intralobar sequestration with anomalous artery from aorta (ab), Vidar Jensen and Aage Wolff, March, 437
- basilar**
- angiographic demonstration of primitive trigeminal artery (carotid-basilar anastomosis), Burton L. Wise, May, 731
- brachiocephalic**
- corner positioning for visualization of brachiocephalic vessels, Israel Steinberg and Bernard K. Ryan, Feb., 242
- carotid.** See also **Brain, blood supply; Thrombosis**
- angiographic demonstration of primitive trigeminal artery (carotid-basilar anastomosis), Burton L. Wise, May, 731
 - buckling of carotid artery demonstrated by angiocardiology (ab), Walter Lentino et al, March, 442
 - granuloma of neck following Thorotrast angiography (ab), Laurence F. Levy, March, 436

ARTERIES, carotid—cont.

- some factors influencing non-visualization of internal carotid artery by angiography (ab), Norman H. Horwitz and Rembrandt H. Dunsmore, Jan., 122

cerebral. See Brain, blood supply**choroid**

- anterior choroidal artery (ab), S. E. Sjögren, May, 761

coronary. See Coronary Vessels**fistula. See Fistula, arteriovenous****innominate. See Arteries, brachiocephalic****mesenteric. See also Aneurysm**

- arterioenteric obstruction of duodenum in adult life and adolescence (ab), Erik de F. Licht, April, 608
- syndrome of mesenteric vascular compression of duodenum; 11 cases with operative correction (ab), Sidney A. Rosenberg and Arnold Sampson, June, 896

- arterial disease as cause of pain in buttock and thigh (ab), George Bonney, June, 893

ophthalmic. See Aneurysm**pulmonary. See also Fistula, arteriovenous; Lungs, blood supply**

- absence of left pulmonary artery in Fallot's tetralogy (ab), Richard W. Emanuel and J. Norman Pattinson, May, 769

- combined tricuspid and pulmonary atresia with juxtaposition of auricles (ab), A. M. Stewart and A. Wynn-Williams, April, 605

- congenital absence of left pulmonary artery (ab), Joseph Smart and J. N. Pattinson, Jan., 130

- dilatation of pulmonary artery in pulmonary stenosis (studied by catheterization and angiocardiology) (ab), F. S. P. van Buchem, March, 442

- radiographic estimation of pulmonary artery pressure in mitral valvular disease, George Jacobson, Leonard H. Schwartz and Marcy L. Sussman, Jan., 15

renal. See also Aneurysm, renal; Fistula

- anatomy of intrarenal arteries in health and disease (ab), F. T. Graves, March, 457

- congenital malformation of renal artery, cause of hypertension, Frank Isaac, Thomas H. Brem, Eugene Temkin and Herbert J. Movius, May, 679

roentgenography. See also other subheads under Arteries

- discussion on clinical and radiological aspects of diseases of major arteries (ab), H. H. G. Eastcott et al, June, 891

- fatality following abdominal arteriography (ab), H. R. Roby and J. W. McKay, Jan., 131

- importance of translumbar aortogram and peripheral arteriogram in management of vascular disease (ab), Andrew G. Sharf et al, May, 768

- new radiologic methods in gynecology: aortography and pelvic arteriography (ab), L. Rossi and B. Maggipinto, Feb., 299

- vascular responses to intra-arterial Diodrast and Urokon during arteriography (ab), Robert S. Shaw, March, 443

- splenic. See Aneurysm, splenic

- trigeminal. See Arteries, basilar

- vertebral. See also Hydrocephalus

- another method of vertebral angiography (ab), E. Lindgren, June, 883

- atrophy within brain stem area following injection of Thorotrast into vertebral artery; case (ab), Tormod Hauge, June, 883

ARTERIOGRAPHY. See Arteries**ARTERIOSCLEROSIS**

- evaluation of peripheral arteriosclerotic insufficiency utilizing radioactive iodinated human serum albumin (ab), Earl J. Halligan, et al, March, 468

ARTHRITIS

- See also Arthritis, Rheumatoid; Spine

- alkaptonuric arthritis (ab), A. J. Harrold, March, 452

- roentgen manifestations of psoriatic arthritis, Thomas F. Meaney and Robert A. Hays, March, 403

ARTHRITIS, RHEUMATOID

- rheumatoid spondylitis and aortic insufficiency (ab), Donald P. Schilder et al, May, 781

ARTHRORHIZY. See Shoulder

- DE ARZUA ZULAICA, E.: Cancer of the gastric stump (ab), Feb., 291

- Hepatic cirrhosis and gastro-duodenal ulcer (ab), Feb., 291

ASCARIASIS

- roentgenological findings of small intestine in 100 repatriated prisoners of war. Deficiency states and worm infestations (ab), Walter Francke, May, 773

ASCITES. See Liver, cirrhosis

- ASHMORE, J. D., KANE, J. J., PETTIT, HAROLD S., and MAYO, HENRY W. Jr.: Experimental evaluation of operative cholangiography in relation to calculus size (ab), May, 775

ASPERGILLOSIS

- aspergilloma of lung (ab), W. Hoffken, Feb., 285

ASTHMA

- chronic pulmonary infiltration with eosinophilia in the asthmatic (5 personal observations, including one with histopathologic analysis) (ab), J. Turiaf et al, Feb., 283

ATELECTASIS. See Lungs, collapse

- ATIK, MOHAMMAD. See WHITTLESEY, ROBERT H.

ATLAS AND AXIS

- basilar impression (ab), A. Tänzer, March, 435

- fracture of odontoid process: 63 cases (ab), Edwin W. Amyes and Frank M. Anderson, Feb., 279

- role of atlantoid compression in etiology of internal carotid thrombosis (ab), Edwin Boldrey et al, Jan., 121

ATMOSPHERE

- RaD, RaE, and Po in atmosphere (ab), P. King et al, April, 636

ATOMIC BOMB AND ATOMIC ENERGY

- disaster monitoring with amateur photographic film and with dental x-ray film, Margaret Ehrlich, Feb., 251

- impact of atomic energy industry on community health; panel discussion (ab), May, 793

- radiological defense plans in California (ab), Stafford L. Warren and Justin J. Stein, Feb., 312

- two ways to estimate thyroid dose from radioiodine in fallout (ab), Gordon M. Dunning, March, 468

AUBRY, P. See PHELINE, CH.

- AURIG, G., and RADKE, H.: Significance of aortography for the diagnosis of abdominal aneurysms (ab), April, 605

AUTORADIOGRAPHY. See Radioactivity**AVEDIAN, VICTOR. See KOVACH, JOHN C.****AXELRAD, B. See SAMPSON, J. J.****AYRES, PERRY R. See FURST, WESLEY**

- AZAMBUJA, N., LINDGREN, E., and SJÖGREN, S. E.: Tentorial herniations (ab), May, 760

B**BABBITT, D. P. See NESBITT, TOM E.****BABER, JULIUS J. See HALLIGAN, EARL J.****BACKACHE**

- comparative roentgen findings in symptomatic and asymptomatic backs, Tom M. Fullenlove and A. Justin Williams, April, 572

- results of lumbosacral fusion for low back pain (ab), E. G. Shaw and J. G. Taylor, March, 455

- treatment of low-back and sciatic pain by injection of hydrocortisone into degenerated intervertebral disks (ab), Henry L. Feffer, April, 612

BACKLUND, VIDAR: Technic of simultaneous telefilmplangiography (ab), April, 618**BACON, A. P. C. See HICKIE, JOHN B.**

- BACON, H. E., and McCREA, L.: Significance of ureteral studies in surgery of the colon and rectum (ab), March, 458

- BACQ, Z. M.: Roentgenoscopic examinations as a hazard to patients (ab), May, 792

BACTEREMIA. See Bacteria**BACTERIA**

- importance of intestinal flora in radiation treatment of gynecological carcinomata (ab), J. Breiter and W. Roth, April, 621

- incidence of endogenous bacteremia in x-irradiated rabbits (ab), Carolyn W. Hammond and C. Phillip Miller, Feb., 315

- temperature dependence of bacterial inactivation by x-rays (ab), G. E. Stapleton and C. W. Edington, June, 918

BADGES. See Roentgen Rays, films

- BAENSCH, WILLY: Rare bony and parosteal tumors in which radioltherapy is not indicated (ab), June, 909

BAGGENSTOSS, ARCHIE H. See BURGERMAN, ARTHUR

- BAIRD, I. McLEAN, and LEES, F.: Renal osteodystrophy in adults (ab), May, 779

BAKAY, LOUIS. See HANELIN, JOSEPH

- BAKWIN, HARRY: Multiple skeletal lesions in young children due to trauma (ab), May, 777

BALANZARIO, ISAIAS. See GARCIA CASTAÑEDA, MÁXIMO

- BALCHUM, OSCAR J. See BLOUNT, S. GILBERT, Jr.

- BALDINI, GIOVANNI, and FERRI, LUIGI: Tumor of bone of vascular origin. Anatomical-radiological considerations of primary hemangioma of the skull (ab), April, 611

- BALDWIN, WILLIAM F.: Similarities in killing by heat and by x-radiation in the insect *Dahlbominus fuscipennis* (Zett.) (ab), May, 796

- BALESTRA, G., and DELPINO, B.: "Spongy" kidney and nephrocalcinosis (ab), June, 903

- BALKWELL, WILLIAM R. See ADAMS, GAIL D.

- BALZARINI, EMILIO, and POMPELLI, GIUSEPPE: Technic and normal radiographic anatomy of the sternum (ab), May, 780

BANTUS. See Negroes**BARBERS. See Industries and Occupations**

- BARCLAY, T. H. CRAWFORD, and KENT, H. P.: Primary carcinoma of the duodenum (ab), Jan., 131

- BARDEN, ROBERT P., and COMROE, JULIUS H., Jr.: Roentgenologic evaluation of pulmonary function. A correlation with physiologic studies of ventilation (ab), Feb., 280

BARILLA, M. See IANNACCONE, G.**BARIUM**

- See also Intestines, roentgenography; Radioactivity, radio-barium

- timed-disintegration capsules: an in vivo roentgenographic study (ab), Theodore M. Feinblatt and Edgar A. Ferguson, Jr., March, 460

BARNETT, ROY N. See DAUZIER, GEORGES**BARONOFKY, IVAN D. See LEVY, LOUIS M.****BARRERA, FRANK. See OPPENHEIMER, M. J.**

- BARTONE, NOEL F., and GRIECO, R. VINCENT: Fractures of the triquetrum (ab), Feb., 297

- BASIĆ, MARKO, and WEBER, DANICA: Damage to the intra-uterine fetus by roentgen rays (ab), Feb., 312

BASILAR IMPRESSION. See Atlas and Axis

- BASSER, ADRIAN G.:** Uptake of radioiodine by the thyroid cells using nuclear emulsion (ab), April, 627.
- BATTEN, RICHARD, and BROWN, D. E. MEREDITH:** Protection of ovaries from radiation (ab), May, 791.
- BAUER, FRANZ K., MUGLER, FREDERICK R., JR., LIEBERMAN, VERNON W., and WESTERGART, JOHN P.:** Clearance of radioactive iodine from the lower extremities of patients with myocardial infarction (ab), May, 788.
- See **TUBIS, MANUEL**
- BAUER, ROBERT E. See CROSBY, R. M. N.**
- BAUMAN, ARTHUR, and ROTHCHILD, MARCUS A.:** The rate of intravascular equilibration of intravenously administered I^{131} -labeled albumin in various body sites (ab), May, 789.
- BAUMGARTNER, J. See WORINGER, E.**
- BAURYS, WILLIAM:** Serious complications associated with the newer diagnostic methods in urology (ab), March, 459.
- BAUS, R. A. See KING, P.**
- BCG VACCINE**
- calcification of regional lymph nodes following BCG vaccination (ab), Samuel C. Stein and Martin J. Sokoloff, Jan., 124.
- BEATTY, E. C., JR. See REIQUM, C. W.**
- BEATTY, OREN A.:** A study of tuberculosis cavities by contrast media and other methods (ab), March, 437.
- BÉCAPTAN DISULFURE LABAZ.** See Roentgen Rays, injurious effects.
- BECK, ROBERT E., KRONSEIN, JOHN, and HOBBS, ARTHUR A. JR.:** Technical considerations in I^{131} tracer studies (ab), June, 911.
- BECKER, JOSEF, and SCHEER, KURT, E.:** Clinical aspects of treatment of carcinomas of the gastrointestinal tract with isotopes (ab), June, 913.
- BEDNARZ, WALLACE W. See SCHEFF, SAUL**
- BEIERWALTES, WILLIAM H., and JOHNSON, PHILIP C.:** Hyperthyroidism treated with radioiodine. A seven-year experience (ab), Feb., 310.
- BELL, H. GLENN. See LOW-BEER, BERTRAM V. A.**
- BELL, P. See CEMBER, H.**
- BELL, ROBERT L., FRIEDMANN, ASA B., and OLSON, B. WESLEY:** Scintiscanning as a method for localization of cerebral tumors (ab), May, 758.
- BELLION, B., TRIBUNO, C., and TORETTA, A.:** Utilization of a 31-MEV betatron for radiation therapy. I. History, principles, installation, protection (ab), June, 910.
- BENADRYL**
- effect in allaying allergic manifestations of 70 per cent Urokon (ab), Jack Lapides and Robert E. Boyd, April, 617.
- BENDER, F.:** Primary pulmonary carcinoma associated with active pulmonary tuberculosis (ab), June, 888.
- BENJAMIN, B. See BRETT, G. Z.**
- BERG, H. M. See BERG, R. M.**
- BERG, HAROLD F. See CHRISTOPHERSON, WILLIAM M.**
- BERG, OWEN C.:** Acute renal failure following translumbar aortography (ab), May, 784.
- BERG, R. M., and BERG, H. M.:** Coproliths, June, 839.
- BERGELSON, VICTOR D. See ISARD, HAROLD J.**
- BERGER, S. M. See KREMENS, V.**
- BERK, J. EDWARD, MELLINS, HARRY Z., and BRODIE, MARVIN:** The use of iodipamide methylglucamine (Cholografin High Potency) as a contrast medium for intravenous cholangiography (ab), Jan., 136.
- BERMAN, CARROLL Z.:** Roentgenographic manifestations of congenital megacolon (Hirschsprung's disease) in early infancy (ab), June, 890.
- BERMAN, HARRY L.:** Immobilization of the head during rotational x-ray therapy, April, 579.
- BERNHHEIM, FREDERICK, OTTOLENGHI, ATHOS, and WILBUR, KARL M.:** Studies on bone marrow lipid in normal and irradiated rabbits (ab), Feb., 314.
- BERRY, N. E., and BURR, R. C.:** Intracavitary irradiation of carcinoma of the bladder (ab), May, 787.
- BERSON, SOLOMON A. See YALOW, ROSALYN S.**
- BERTOLOTI, MARIO:** Inflammatory craniopathies. Various stages in the development of a theory (ab), Feb., 278.
- BESSE, BYRON E., JR. See RUBIN, PHILIP**
- BEST, WILLIAM R., LANDMANN, WENDELL A., and LIMARZI, LOUIS R.:** Time pattern of vitamin $B_{12}Co^{60}$ urinary excretion in man after oral administration and parenteral "flushing" (ab), March, 472.
- WHITE, WILFRID F., ROBBINS, KENNETH C., LANDMANN, WENDELL A., and STEELMAN, SANFORD L.:** Studies on urinary excretion of vitamin $B_{12}Co^{60}$ in pernicious anemia for determining effective dosage of intrinsic factor concentrates (ab), March, 471.
- BETA RAYS.** See Eyes; Radioactivity, radiostrontium
- BETATRON**
- effect of radiation on esophagus; clinical and histologic study of effects produced by betatron. William B. Seaman and Lauren V. Ackerman, April, 534.
- measurement of ratio E_{α}/J_{α} for betatron radiation, I. D. Skarsgard, D. V. Cormack and H. E. Johns, Feb., 257.
- studies of dose distributions in water for betatron x-rays up to 37 MEV (ab), B. Zendle et al., June, 910.
- utilization of 31-MEV betatron for radiation therapy. I. History, principles, installation, protection (ab), B. Bellion et al., June, 910.
- BÉTOULIÈRES, P., CARABALONA, P., PÉLISSIER, M., and CAUDON, J.:** Pneumotracheography in the investigation of the left lobe of the liver (ab), Feb., 293.
- BETTI, ROBERTO. See GARDINI, GIOVANNI F.**
- BIANCHI, EMO:** Roentgenologic findings in uretero-appendicular fistula (ab), Jan., 141.
- BICKEL, WILLIAM H. See SABANAS, ALVINA O.**
- BIGNALL, J. R.:** Bronchial carcinoma. Effect of radiotherapy on survival (ab), May, 786.
- BILE**
- biliary tract studies. I. X-ray diffraction analysis of gallstones: correlation with occurrence of microspherosolites in bile (ab), Kerrison Juniper, Jr., and William E. Woolf, Jan., 134.
- BILE DUCTS**
- See also Biliary Tract
- bile ducts of cholecystectomized patients with and without dyskinesia before and after morphine injection. Preliminary report (ab), Eric Gunnarson, Feb., 294.
- calculi**
- experimental evaluation of operative cholangiography in relation to calculus size (ab), J. D. Ashmore et al., May, 775.
- residual common duct calculi (ab), A. O. Singleton, Jr., and James L. Coleman, March, 449.
- residual stone in biliary ducts (ab), Frank B. Thomson, May, 774.
- cancer**
- hepatic duct carcinoma seventeen years after injection of thorium dioxide (ab), James C. Roberts, Jr., and Kenneth E. Carlson, May, 791.
- BILES, E. WILEY. See SINGLETON, EDWARD B.**
- BILIARY TRACT**
- See also Bile Ducts; Gallbladder; Liver
- clinical significance of air and barium in biliary tract (ab), Earl J. Halligan and Julius J. Baber, June, 897.
- cysts**
- radiographic demonstration of choledochal cyst by oral cholecystography, John E. Moseley, June, 849.
- fistula. See Fistula**
- roentgenography. See also Gallbladder**
- advantages and disadvantages of morphine effect combined with Biligran examination (ab), A. Boris and P. Lörinc, Jan., 136.
- cholangiographic diagnosis of pancreatitis (ab), Maurice D. Sachs and Philip F. Partington, June, 897.
- cholangiography after cholecystectomy: visualization with Cholografin by vein (ab), Stanley B. Reich et al., March, 450.
- cholecystography and cholangiography: review of present methods of examination (ab), Noel H. Aldridge, April, 609.
- comparative study of newer contrast media (Teridax, Telepaque, and Cholografin) used in cholecystography and cholangiography (ab), Carl P. Wisoff and Benjamin Felson, May, 774.
- evaluation of cystic duct stump in intravenous cholangiography (ab), L. Fried, May, 775.
- evaluation of routine operative cholangiography (ab), Deward O. Ferris and Harry M. Weber, June, 897.
- experiences with diagnostic angiography and "per-operative radionuclonometry" in cholelithiasis (ab), A. Ritter and H. Helmig, March, 450.
- interpretation of intravenous cholangiogram (ab), Robert E. Wise and Richard G. O'Brien, Jan., 135.
- intravenous cholangiographic diagnosis of partial obstruction of common bile duct, Robert E. Wise, David O. Johnston and Ferdinand A. Salzman, April, 507.
- intravenous cholangiography as aid in diagnosis of carcinoma of head of pancreas, George Levene and Saul Scheff, May, 714.
- intravenous cholecyst-cholangiography in emergency abdominal diagnosis (ab), Robert S. Sparkman and Paul R. Ellis, March, 450.
- operative cholangiograms; critical review of their value (ab), John D. Adams and R. D. Noel, Jan., 135.
- operative cholangiography; survey of 83 cases in 232 cholecystectomies (ab), Royal A. Weir and Carlos Lizama, Feb., 294.
- percutaneous transhepatic cholangiography (ab), Jorge Remolar et al., May, 775.
- per-operative manometry and radiology in biliary tract disorders (ab), Pierre Mallet-Guy and J. Dudfield Rose, May, 775.
- use of iodipamide methylglucamine (Cholografin High Potency) as contrast medium for intravenous cholangiography (ab), J. Edward Berk et al., Jan., 136.
- surgery. See Biliary Tract, roentgenography**
- BILIGRAFIN. See Biliary Tract; Gallbladder**
- BIOPSIES. See Spine, cancer**
- BIRCHALL, I. See JONES, D. E. A.**
- BIRKNER, RUDOLPH, FREY, JULIUS, and UEBERSCHÄR, KARL-HEINZ:** Early changes of bone of adult guinea pigs after roentgen irradiation (ab), June, 917.
- BIRZLE, H.:** Roentgen demonstration of the movements of the ciliated epithelium of the trachea: experiments on isolated tracheas of slaughtered animals (ab), March, 436.
- BITTNER, JOHN J. See BOUCHER, NORMAN E., JR.**
- BLADDER**
- cystitis and ureteritis emphysematosa, C. Soteropoulos, E. Kawashima and John H. Gilmore, June, 800.
- dose decrease in bladder and rectum in gynecologic radium treatments (ab), August Verhagen, Jan., 146.

BLADDER—cont.

- ureteritis cystica and pyelitis cystica; review of cases and roentgenologic criteria, Bernard S. Loitman and Harold Chiat, March, 345

cancer

- aftercare following intraluminal cobalt therapy for carcinoma (ab), Robert E. Schick, Feb., 312
- experiences with radioactive chromic phosphate in urological tumors (ab), Vincent Moore et al, Feb., 311
- intracavitary irradiation of carcinoma (ab), N. E. Berry and R. C. Burr, May, 787
- reliability of roentgen signs of varying degrees of malignancy of tumors (ab), C. Franksson et al, Feb., 301
- study of 2,678 patients with initial carcinoma. I. Survival rates. II. Survival rates in relation to therapy (ab), F. K. Mostofi, Jan., 146
- therapy of carcinoma (ab), Ira H. Lockwood and Samuel B. Chapman, Jan., 146

 fistula. See Fistula**roentgenography**

- cystourethrography; clinical experience with newer contrast media (ab), Joseph J. Kaufman and Murray Russell, March, 458
- simple instrument for urethrocytography and fistulography in adults and children (ab), Åke Gullmo, April, 616
- urethrocytographic classification of prostatism (ab), M. L. Brodny and S. A. Robins, March, 459
- urethrocytography in differential diagnosis of prostatic cancer (ab), K. J. Oravisto and S. Schaumann, April, 615

tumors

- reliability of roentgen signs of varying degrees of malignancy (ab), C. Franksson et al, Feb., 301

BLASTOMYCOSIS

- of bone; 4 cases (ab), Peter L. Carnesale and Kenneth F. Stegman, June, 898
- roentgen aspects of intrathoracic blastomycosis (ab), Chapin Hawley and Benjamin Felson, Feb., 284

BLIFFORD, I. H., Jr. See KING, P.

- BLOEDORN, FERNANDO G.:** Application of the Paterson-Parker system in interstitial radium therapy (ab), Jan., 149

- BLOMFIELD, G. W.:** Clinical evaluation of results in super-voltage x-ray therapy (ab), Feb., 306

BLOOD

- See also Anemia; Erythrocytes; Hemopoietic System; Leukocytes

- plasma, tissue and urinary radioactivity after oral administration of ^{59}Co -labeled vitamin B₁₂ (ab), C. C. Booth and D. L. Mollin, May, 789
- recording of radioactivity in blood, liver, and prostate following interstitial administration of Au¹⁹⁸ in carcinoma of prostate (ab), Wayne M. Rounds and Titus C. Evans, April, 629
- transfer of potassium between blood, cerebrospinal fluid and brain tissue (ab), Guilford G. Rudolph and Norman S. Olsen, May, 789

albumin. See Blood, proteins**calcium**

- radiographic features of severe idiopathic hypercalcemia of infancy, Edward B. Singleton, May, 721
- roentgen findings in patients with high serum calcium, Marvin L. Daves, David M. Gould and Gunter Schultze, Jan., 48

carbon dioxide

- in vivo visualization of intracardiac structures with gaseous carbon dioxide; cardiovascular-respiratory effects and associated changes in blood chemistry (ab), M. J. Oppenheimer et al, June, 893

circulation. See also Brain, blood supply; Lungs, blood supply; etc.

- angiocardigraphic mixing defects as indicators of left to right shunts (ab), Melvin M. Figley et al, April, 603
- angiocardigraphic observations of intracardiac flow in the normal and in mitral stenosis (ab), Louis A. Soloff et al, Jan., 128
- congenital peripheral arteriovenous communications; use of femoral artery to heart circulation time in diagnosis (ab), Thomas O. Murphy et al, June, 893
- isotope studies of blood flow and blood cells (studied by radiocardiography) (ab), Edith H. Quimby, April, 624
- rate of intravascular equilibration of intravenously administered ^{125}I -labeled albumin in various body sites (ab), Arthur Bauman and Marcus A. Rothschild, May, 789
- simple angiographic method for study of greater circulation; "enlarged" angiocardipneumography (ab), P. Viallet et al, March, 443

fat and lipids

- incorporation of N^{15} -labeled glycine in plasma protein, plasma phospholipids, blood non-protein nitrogen, and splenic tissue in man (ab), D. S. Amatuzio et al, March, 472

iodine. See also Blood, proteins

- determination of protein-bound radioiodine with an anion exchange resin (ab), Leslie Zieve et al, March, 469
- salivary and thyroidal radioiodide clearances of plasma in various states of thyroid function (ab), Karl Fellingner et al, Feb., 309

lipoproteins

- x-irradiation and lipoprotein metabolism in various species (ab), John E. Hewitt and Thomas L. Hayes, April, 636

nitrogen

- incorporation of N^{15} -labeled glycine in plasma protein, plasma phospholipids, blood non-protein nitrogen, and splenic tissue in man (ab), D. S. Amatuzio et al, March, 472

plasma. See also other subheads under Blood

- effect of total-body x-irradiation on plasma volume, red cell volume, blood volume and thiocyanate space in normal and splenectomized rats (ab), Kee-Chang Huang and James H. Bondurant, April, 635
- plasma activity levels in radioiodine tests of thyroid function (ab), H. A. Hughes and R. M. Miller, Jan., 150
- studies on copper metabolism. XXI. Transfer of radio-copper between erythrocytes and plasma (ab), J. A. Bush et al, March, 472
- urinary excretion and plasma levels of free ninhydrin reactive compounds in x-irradiated rats (ab), R. E. Kay et al, May, 796

proteins. See also Blood, lipoproteins

- disulfide reduction and release of iodide 131 following irradiation of ^{131}I labeled proteins, Rosalyn S. Yalow and Solomon A. Berson, Jan., 100
- early disappearance of ^{125}I serum albumin from circulation of edematous subjects and its implications in clinical determination of blood volume (ab), T. W. Moir et al, March, 469
- evaluation of peripheral arteriosclerotic insufficiency utilizing radioactive iodinated human serum albumin (ab), Earl J. Halligan et al, March, 468
- incorporation of N^{15} -labeled glycine in plasma protein, plasma phospholipids, blood non-protein nitrogen, and splenic tissue in man (ab), D. S. Amatuzio et al, March, 472
- investigations of transfer rates of albumin tagged with ^{125}I in ascites and edema. II. Studies in control subjects and patients with cirrhosis (ab), James A. Schoenberger et al, March, 469
- rate of intravascular equilibration of intravenously administered ^{125}I -labeled albumin in various body sites (ab), Arthur Bauman and Marcus A. Rothschild, May, 789

serum. See Blood, calcium; Blood, proteins**transfusion**

- determination of cell volume in massive transfusions using Fe^{59} and Cr^{51} (ab), E. L. Smith et al, May, 790
- effect of transfusions of blood showing extreme leukocytosis on survival of x-irradiated mice (ab), C. C. Congdon et al, April, 634

volume

- changes in cases of cerebral trauma as determined by radioactive isotopes (ab), Edmund A. Smolik et al, Jan., 152
- determinations with radioactive chromium (Cr^{51}) labeled erythrocytes; feasibility of routine total red blood cell volume determinations in general hospital (ab), Leo M. Meyer, Feb., 311
- early disappearance of ^{125}I serum albumin from circulation of edematous subjects and its implications in clinical determination of blood volume (ab), T. W. Moir et al, March, 469
- effect of total-body x-irradiation on plasma volume, red cell volume, blood volume and thiocyanate space in normal and splenectomized rats (ab), Kee-Chang Huang and James H. Bondurant, April, 635
- some applications of isotope dilution techniques (ab), Rosalyn S. Yalow and Solomon A. Berson, April, 624

BLOOD PRESSURE

- blood pressure and heart rate during angiocardiology, abdominal aortography, and arteriography of lower extremities (ab), A. K. Amundsen et al, April, 604

high. See also Portal Vein

- congenital malformation of renal artery, a cause of hypertension, Frank Isaac, Thomas H. Brem, Eugene Temkin and Herbert J. Movius, May, 679

BLOOD VESSELS

- See also Aorta; Arteries; Cardiovascular System; Lungs; Veins; etc.

- early vasoconstriction induced in isolated rabbit's ear by x-radiation (ab), Phillips M. Brooks et al, April, 635

roentgenography

- granuloma of neck following Thorotrast angiography (ab), Laurence F. Levy, March, 436
- improved syringe for angiography (ab), B. Selverstone et al, March, 461
- simple angiographic method for study of greater circulation; "enlarged" angiocardipneumography (ab), P. Viallet et al, March, 443

- BLOUNT, S. GILBERT, Jr., BALCHUM, OSCAR J., and GEN-SINI, GOFFREDO:** The persistent ostium primum atrial septal defect (ab), Feb., 287

BLUM, S. DANIEL. See MARSHAK, RICHARD H.

- BLUTH, IRWIN:** A note on the roentgen features of bronchial adenoma of the peripheral type, Feb., 193

BOAG, J. W. See ZENDLE, B.**BOCKUS, H. L. See MITCHELL, ROBERT E., Jr.****BODY-SECTION ROENTGENOGRAPHY**

- evaluation of different radiologic methods (Dionasil, mucosography, tomography) in diagnosis of carcinoma of lung (ab), Laura Fariñas et al, June, 889

- few cases of glandular-bronchial fistula (importance of body-section roentgenography) (ab), Armando Pinheiro and Fernando Outeiro, Jan., 127

BODY-SECTION ROENTGENOGRAPHY—cont.

- focal calcifying necrotizing pneumonia and its differentiation (especially by stratigraphy) from carcinoma of bronchus (ab). E. Zdansky, May, 763
- headache from subluxations of cervical articulations (studied by tomography) (ab). Ákos Kovács, June, 887
- pantomography of deep layers; preliminary report (ab). Pekka Soila, March, 461
- pneumostratigraphy in investigation of left lobe of liver (ab). P. Bétoulières et al., Feb., 293
- prognosis and early diagnosis of non-union of femoral neck fractures by laminagraphy (ab). Norman Rosenberg et al., June, 902
- radiologic study of intrathoracic goiter with axial transverse stratigraphy (ab). A. Santagada and M. Piazzi, Jan., 127
- retrobulbar air injection with planigraphy (ab). G. Richard Keskey and William R. Letsch, June, 886
- segmental radiography of internal auditory canal in neuromas of eighth nerve (ab). H. Fischgold et al., May, 761
- suboccipital gas myelography (combined with tomography) in diagnosis of herniated disc in cervical segment (ab). H. H. Jacobsen, May, 783
- technic of simultaneous telefilmplanigraphy (ab). Vilar Backlund, April, 618
- tomographic studies on normal and injured knee (ab). Stig Fagerberg, Feb., 298
- use of different tube shifts in lung tomography. Hans Salinger and Hannah Friedman-Barou, Feb., 209

BOECK'S SARCOID. See Sarcoidosis

BOESSEN, B. LIND, JOHN, MERRILL-HANSEN, B., ROSENDAAL, TH., STORM, OLE, and WEGELIUS, CARL. Diagnosis of congenital heart disease in infants by catheterization and selective angiocardiology (ab), May, 768

BOLDREY, EDWIN, MAASS, LYMAN, and MILLER, EARL. Role of atlantoid compression in the etiology of internal carotid thrombosis (ab), Jan., 121

BOND, V. P., CARTER, R. E., ROBERTSON, J. S., SEYMOUR, P. H., and HECHTER, H. H. Effects of total-body fast neutron irradiation in dogs (ab), Feb., 316

—See **CARTER, R. E.**

—See **SWIFT, MARGUERITE N.**

BONDURANT, JAMES H. See **HUANG, KEE-CHANG**

BONES

- See also Cranium; Spine; under names of bones
- autoradiographic study of organically bound carbon-14 in growing epiphyseal cartilage and bone (ab). Richard C. Greulich, April, 632
- early changes of bone of adult guinea-pigs after roentgen irradiation (ab). Rudolph Birkner et al., June, 917

abnormalities

- unusual osteochondroses presenting diagnostic difficulty (ab). Howard E. Le Bus, June, 898

atrophy

- renal osteodystrophy in adults (ab). I. McLean Baird and F. Lees, May, 779

cancer

- bone lesions secondary to cancer of uterus (ab). J. Roussel et al., March, 453
- localization of radioactive gallium (Ga^{67}) in bone lesions (ab). H. C. Dudley et al., April, 631
- osseous metastasis of thyroid origin (ab). A. K. Datta Gupta, Feb., 296
- skeletal metastases in cancer of breast (ab). Charles J. Staley, April, 610

cysts

- aneurysmal cyst (ab). Miguel Cruz and Bradley L. Coley, May, 777
- aneurysmal cyst: its roentgen diagnosis, Robert S. Sherman and Kenneth Y. Soong, Jan., 54

diseases. See also Bones, pathology; Osteochondritis; Osteomyelitis

- fibrous dysplasia; analysis of 15 cases of surgically verified costal fibrous dysplasia (ab). James F. Zimmer et al., Feb., 295
- joint and bone disease due to mycotic infection (ab). Elam C. Toome, Jr., and John Kelly, Jan., 138
- localization of radioactive gallium (Ga^{67}) in bone lesions (ab). H. C. Dudley et al., April, 631
- metaphyseal fibrous defects (ab). James B. Cunningham and Lauren V. Ackerman, May, 778
- progressive diaphyseal dysplasia (Engelmann's disease) (ab). H. B. Stewart and E. R. Cole, Feb., 295

fractures. See Fractures

fragility

- unusual cystic lesion of bone, limited to pelvis and lower extremities. Osteogenesis imperfecta cystica? Charles A. Bream and William H. Sprunt, III, Feb., 179

growth

- animal experiments on radiosensitivity of growing bone (ab). Pierre van Caneghem and Carl G. Schirren, May, 796

infarction

- bone infarcts in sickle-cell anemia, Caroline W. Rowe and Mary E. Haggard, May, 661
- roentgen manifestations of caisson disease (ab). Maxwell H. Poppel and William T. Robinson, May, 779

marrow

- comparative activity of isologous vs. homologous or heterologous mouse bone marrow in promoting regeneration of irradiated mouse thymus (ab). Barbara B. Hirsch et al., May, 795
- dangers and technic of osteomyelography and transosseous venography (ab). H. J. Süssé, June, 906

- multiple myeloma; case diagnosed without x ray evidence of bone lesions (ab). Morris E. Freedland, March, 452
- studies on bone marrow lipid in normal and irradiated rabbits (ab). Frederick Bernheim et al., Feb., 314
- technic of making microangiograms of rabbit bone marrow (ab). Chiyeo Okawa and J. I. Trombka, June, 907

mycosis. See Blastomycosis**pathology**

- bone changes in Kaposi's sarcoma; analysis of 15 cases occurring in Bantu Africans (ab). A. G. M. Davies, May, 779
- bone changes in leprosy (ab). D. E. Paterson, March, 453
- bone changes in tropical ulcer (ab). J. Scott Brown and J. H. Middlemiss, Feb., 296
- bone (osteoporosis), joint and soft-tissue changes following paraplegia (ab). Thomas Lodge, May, 780
- hyperostosis generalisata (ab). Marie Fogel and Rose Fejer, Jan., 138
- infantile cortical hyperostosis (ab). Fred Brooksaler and J. E. Miller, April, 611
- radiographic features of severe idiopathic hypercalcemia of infancy, Edward B. Singleton, May, 721
- radiologic and pathologic bone changes associated with urticaria pigmentosa; case (ab). Ernest Stark et al., June, 869
- roentgen findings in patients with high serum calcium, Marvin L. Daves, David M. Gould and Gunter Schultze, Jan., 48
- roentgenographic study of skeletal lesions in sarcoidosis (ab). George N. Stein et al., March, 453
- unusual bilateral sacrococcygeal ossicles, William S. Cornwell and George H. Ramsey, Jan., 70

roentgenography. See other subheads under Bones

- tumors.** See also under names of bones
- angiosarcoma; review of literature and presentation of case (ab). John H. Carter et al., May, 778
- atypical reticulum-cell sarcoma of skeletal system (ab). G. Keiser and H. Hartmann, June, 898
- grading of osteogenic sarcoma, and its bearing upon survival and prognosis (ab). C. H. G. Price, Feb., 302
- histological diagnosis of undifferentiated tumors (ab). T. F. Hower, Feb., 302
- non-osteogenic fibroma of bone (fibrous metaphyseal defect) (ab). Roy H. Maudsley and Alfred G. Stansfeld, June, 898
- osteomyelitis and sarcoma (ab). F. De Witte, Jan., 139
- radiosensitive tumors—radiological aspects (ab). F. G. M. Ross, Feb., 302
- radiotherapy of xanthomatous giant-cell tumors (ab). Sven Hultberg and V. Belloch Zimmermann, June, 909
- rare bony and parosteal tumors in which radiotherapy is not indicated (ab). Willy Baensch, June, 909
- solitary eosinophilic granuloma (ab). T. Hunter, March, 452
- some radiosensitive tumors (ab). A. L. Eyre-Brook, Feb., 302
- some radiosensitive tumors (ab). Robert C. Tudway, Feb., 302

wounds and injuries

- multiple skeletal lesions in young children due to trauma (ab). Harry Bakwin, May, 777

BONGIOVANNI, ALFRED M. See **NAGLE, W. WILLIAM**

BONNEY, GEORGE. Arterial disease as a cause of pain in the buttock and thigh (ab), June, 893

BONTE, FREDERICK J. See **COLE, JACK W.**

BOOK REVIEWS

Astley, Roy. Radiology of the Alimentary Tract in Infancy, March, 429

Atlas of Tumor Pathology. Armed Forces Institute of Pathology, Jan., 111

Betz, E. H. Contribution à l'étude du syndrome endocrinien provoqué par l'irradiation totale de l'organisme, Jan., 111

Bevilacqua, Renato. Attuale orientamento nella radiodiagnostica delle malattie toraciche. (Possibilità e limiti della comune tecnica radiologica), Feb., 271

Brombart, Marcel. La radiologie clinique de l'oesophage, April, 588

Candardjijs, Georges. Diagnostic différentiel radiologique des ulcérations gastriques, June, 875

Castleman, Benjamin. Tumors of the Thymus Gland, Jan., 111

Cooley, Robert N., and Sloan, Robert D. Radiology of the Heart and Great Vessels, April, 587

de Lorimer, Alfred A., Mochring, Henry G., and Hannan, John R. Clinical Roentgenology. Volume IV. The Digestive Tract, the Gall Bladder, Liver and Pancreas, the Excretory Tract and Special Studies Emphasizing Differential Considerations, March, 429

Dulac, G. L. Études sur la précision en radiodiagnostic. Techniques d'un nouveau craniographe. Notation angulaire de l'incidence, May, 746

Ennuyer, A., and Bataini, J.-P. Les tumeurs de l'amygdale et de la région velopalatine, Feb., 271

Fossati, F., Gallone, P., Parmeggiani, L., Polvani, C., and Scolari, M., compilers. Norme per le protezioni contro le radiazioni ionizzanti, Jan., 113

Garbay, Jean, Garbay, Michel, and Vanderpooten, Claude. Les écoulements thoraciques, May, 745

García-Caldéron, J., and Ledoux-Lebard, G. Technic of radio-diagnostic, March, 430

Greenstein, Jesse P., and Haddow, Alexander. Advances in Cancer Research. Vol. IV, June, 874

Gutmann, René A. Le diagnostic du cancer d'estomac à la période utile, April, 588

BOOK REVIEWS—cont.

- Hadley, Lee A. The Spine. *Anatomico-Radiographic Studies. Development and the Cervical Region*, Jan., 111
- Hertz, Arthur T., and Mansell, Hazel. Tumors of the Female Sex Organs. Part I. Hydatidiform Mole and Chorioncarcinoma, Jan., 111
- Hine, Gerald J., and Brownell, Gordon L. Radiation Dosimetry, Feb., 270
- Holt, John Floyd, Hodges, Fred Jenner, Jacox, Harold W., and Kligerman, Morton M., editors. The Year Book of Radiology (1956-57 Year Book Series), June, 874
- Hornykiewytch, Th. Intravasculaire Cholangiographie. Grundlagen, Technik, Ergebnisse, Feb., 271
- Janker, R., Grosse-Brockhoff, F., Haubrich, R., Lotzkes, H., Schaepe, A., and Hallerbach, H. Die Röntgen-Untersuchung des Herzens und der grossen Gefässe. Vorträge des 1. Bonner Röntgenologischen Wochenendkurses, June, 874
- Jarniou, A.-P. Diagnostics pneumologiques, May, 745
- Lacassagne, A., and Gricouloff, G. Action des radiations ionisantes sur l'organisme, March, 430
- Landing, Benjamin H., and Farber, Sidney. Tumors of the Cardiovascular System, Jan., 111
- Meschan, Isadore. Roentgen Signs in Clinical Diagnosis, May, 744
- Oughterson, Ashley O., and Warren, Shields, editors. Medical Effects of the Atomic Bomb in Japan, May, 744
- Pendergrass, Eugene P., Schaeffer, J. Parsons, and Hodes, Philip J. The Head and Neck in Roentgen Diagnosis, June, 873
- Physiology and Pathology of the Kidney. A Symposium, April, 588
- Prevedi, Giorgio, and Marcato, Marco. Microradiografia ossea. Sviluppo e accrescimento dello scheletro umano. Cranio e colonna vertebrale, June, 875
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- Schmidt, Paul-Georg. Die Lungentuberkulose. Diagnose und Therapie, May, 745
- Schmori, G., and Junghanns, H. Clinique et radiologie de la colonne vertebrale normale et pathologique. Confrontation anatomo-pathologique, April, 589
- Schoen, Herbert. Medizinische Röntgentechnik. Lehrbuch für medizinisch-technische Assistentinnen, Ärzte und Studierende, in zwei Teilen. Medizinischer Teil: Skelettaufnahmen und Organuntersuchungen, May, 744
- Swohoda, W. Das Skelett des Kindes. Entwicklung, Bildungsfehler und Erkrankungen, April, 589
- Thoms, Herbert. Pelvimetry, Feb., 270
- Thurn, P. Hämodynamik des Herzens im Röntgenbild mit besonderer Berücksichtigung der Herzkatheterisierung und der Angiokardiographie. Fortsch. a. d. Geb. d. Röntgenstrahlen, Ergänzungsband 78, Jan., 112
- Tori, G., Brusori, G., Miceli, R., and Zaffagnini, E. Strati-terapia bifocale, Jan., 112
- Wilson, C. W. Radium Therapy. Its Physical Aspects and Extensions with Radioactive Isotopes, April, 587
- Zimmerman, H. M., Netsky, Martin G., and Davidoff, Leo M. Atlas of Tumors of the Nervous System, June, 874
- BOOKS RECEIVED (not reviewed)**
- Albot, G., et al. Intestin grêle: Colon-rectum, May, 743
- Allsopp, C. B., editor. The Measurement of Body Radioactivity, May, 743
- André, Torsten. Studies on the Distribution of Tritium-Labeled Dihydrostreptomycin and Tetracycline in the Body. Acta radiol suppl. 142, May, 743
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- Bensaude, R. Rectosigmoidoscopy, May, 743
- Brocher, J. E. W. Die Prognose der Wirbelsäulenleiden. Eine berufspräventive Betrachtung, June, 873
- Bugher, J. C., Coursaget, J., and Loutit, J. F., editors. Progress in Nuclear Energy. Ser. VI, Biological Sciences. Vol. I, Jan., 110
- Bugher, J. C., Coursaget, J., and Loutit, J. F., editors. Progress in Nuclear Energy. Ser. VII, Medical Sciences. Vol. I, Jan., 110
- Clark, K. C. Positioning in Radiography, April, 586
- Cocchi, Umberto. Retroperitoneum und Pneumomediastinum, June, 873
- Cronkite, E. P., Bond, V. P., and Dunham, C. L., editors. Some Effects of Ionizing Radiation on Human Beings. A Report on the Marshallese and Americans Accidentally Exposed to Radiation from Fallout and a Discussion of Radiation Injury in the Human Being, Feb., 269
- Ferguson, Albert B. Orthopedic Surgery in Infancy and Childhood, May, 742
- Fields, Theodore, and Seed, Lindon. Clinical Use of Radioisotopes. A Manual of Technique, May, 743
- Greitz, Torgny. A Radiological Study of the Brain Circulation by Rapid Serial Angiography of the Carotid Artery. Acta radiol. suppl. 140, May, 743
- Halasinsky, M., editor. Actions chimiques et biologiques des radiations. Deuxième série, April, 587
- Hertz, Helge, and Rosendal, Thomas. Roentgen Changes in the Cranium in 153 Intracranial Tumours in Children Aged 0-15 Years. Acta radiol. suppl. 141, May, 743
- Hewitt, Richard M. The Physician-Writer's Book. Tricks of the Trade of Medical Writing, March, 428
- Ioannou, Jean. Guide technique et topographique d'exploration bronchologique (Bronchoscopie et bronchographie), May, 743
- Isemein, L., and Fournier, A.-M. La polyarthrite chronique évolutive, April, 587
- Janker, R., Grosse-Brockhoff, F., Haubrich, R., Lotzkes, H., Schaepe, A., and Hallerbach, H. Die Röntgen-Untersuchung des Herzens und der grossen Gefässe, Jan., 111
- Kyker, Granvil C., and Anderson, Elizabeth B., editors. Rare Earths in Biochemical and Medical Research: A Conference Sponsored by Medical Division, Oak Ridge Institute of Nuclear Studies, October 1955, March, 428
- Léger, Lucien, and Bréhan, Jacques. Chirurgie du pancreas, May, 743
- Merck Manual of Diagnosis and Therapy, Jan., 110
- Müller, Maurice E. Die Hüftnahen Femurosteotomien unter Berücksichtigung der Form, Funktion und Beanspruchung des Hüftgelenkes, June, 873
- Nadas, Alexander S. Pediatric Cardiology, March, 428
- National Research Council, The Biological Effects of Atomic Radiation. Summary Reports from a Study by the National Academy of Sciences, May, 743
- Proceedings of the Third National Cancer Conference. Detroit, Michigan, June 4-6, 1956, April, 586
- Puijlaert, Carl B. A. G. Radiological Diagnosis of Bronchiectasis, April, 587
- Radiation Safety and Major Activities in the Atomic Energy Programs, April, 586
- Rajewsky, B. Strahlendosis und Strahlenwirkung. Tafeln und Erläuterungen; Unterlagen für den Strahlenschutz, Jan., 110
- Schubert, Jack, and Lapp, Ralph E. Radiation: What It Is and How It Affects You, June, 873
- Smullen, Willard C. Basic Foundations of Isotope Technique for Technicians, April, 586
- Spector, William S., editor. Handbook of Biological Data, March, 428
- Stenstrom, K. Wilhelm. Manual of Radiation Therapy, June, 873
- Storch, Charles B. Fundamentals of Clinical Fluoroscopy, with Essentials of Roentgen Interpretation, Feb., 269
- Sullivan, William H. Trilinear Chart of Nuclides, June, 873
- Tracy, John E. The Doctor as a Witness, May, 743
- Wachsmann, Felix, and Dimotis, Alexander. Kurven und Tabellen für die Strahlentherapie, June, 873
- Werthenbacher, Lael Tucker. Death of a Man, April, 587
- BOOTH, C. C., and MOLLIN, D. L.: Plasma, tissue and urinary radioactivity after oral administration of ^{14}C -labelled vitamin B₁₂ (ab), May, 789
- BOREN, H. G., and MILLER, D. V.: Evaluation of 3,5-diiodo-4-pyridone N-acetic acid (Dionosil) as a bronchographic agent (ab), June, 888
- BORIS, A., and LÖRINC, P.: Advantages and disadvantages of the morphine effect combined with Bilgrafin examination (ab), Jan., 136
- BORRELLI, F. J., and MAGLIONE, A. A.: Importance of myelography in spinal pathology. Analytical study of 150 cases (ab), June, 900
- BOUCHER, NORMAN E., Jr., SYVERTON, JEROME T., and BITTNER, JOHN J.: Effect of radiophosphorus and cortisone on transplanted mammary adenocarcinomas in susceptible and resistant mice (ab), May, 789
- BOUCHILLON, C. D. See ETTMAN, IRVING K.
- BOUDREAU, ROBERT P. See DENNIS, JOHN M.
- BOURNE, N. W. See NESBITT, TOM E.
- BOVINGTON, MARY. See THOMAS, CHARLES I.
- BOWERS, WALTER F. See NELSON, THOMAS G.
- BOWSER, EVERETT N. See FIELDS, THEODORE
- BOYD, ROBERT E. See LAPIDES, JACK
- BRADY, BOYER M., and CARROLL, DAVID S.: The significance of the calcified appendiceal enterolith, May, 648
- See MITCHUM, WILLIAM R.
- BRAIN**
- See also Cerebellum; Meninges; Pituitary Body; Sella Turcica; etc.
- automatic brain scanner for use with gamma-ray-emitting isotopes, W. B. Reid and H. F. Johns, Feb., 259
- normal variations in position of optic recess of third ventricle (ab), James Bull, May, 753
- prompt effects of whole-body irradiation at high dose rate on electroencephalogram of monkeys (ab), Phillips M. Brooks, March, 475
- time-intensity factors in radiation response. I. Acute effects of megavolt electrons (cathode rays) and high- and low-energy x-rays with special reference to brain (ab), Samuel P. Hicks et al., Jan., 134
- transfer of potassium between blood, cerebrospinal fluid and brain tissue (ab), Guilford G. Rudolph and Norman S. Olsen, May, 789
- atrophy**
- atrophy within brain stem area following injection of Thorotrast into vertebral artery; case (ab), Tormod Hauge, June, 883
- blood supply.** See also Arteries, cerebral; Brain, hematoma; Brain, tumors; Thrombosis

BRAIN, blood supply—cont.

- angiographic findings in cerebral vascular disease and their relationship to clinical syndromes (ab), R. Frowein, May, 756
- another method of vertebral angiography (ab), E. Lindgren, June, 883
- arteriovenous aneurysm of posterior fossa in an infant; case (ab), E. C. Schultz and William A. Huston, Jan., 121
- cerebral angiographic studies following surgical treatment of intracranial aneurysms; angiographic evaluation of results (ab), Lester A. Mount and Juan M. Taveras, June, 882
- cerebral angiography in encephalotrigeminal angiomatosis, Charles M. Poser and Juan M. Taveras, March, 327
- cerebral angiography in neurosurgical service (ab), Stevens Dimant et al, May, 754
- cerebral cineangiography with image intensifier (ab), H. Verbiest and J. Feddema, June, 907
- cerebral serial angiography (by means of fluorography) on 70 mm film size (ab), Heinz Vieten, June, 882
- changes in superficial veins in cases of intracranial expanding processes (ab), V. Gvozdanović, May, 757
- contributions to cerebral angiography (ab), H. Neuen-schwander and H. R. Renfer, May, 758
- indications for and technic of cerebral angiography (ab), Curwood R. Hunter, Jan., 122
- new method of total simultaneous cerebral angiography by rapid intravenous injection (ab), P. Viallet et al, May, 755
- rapid serial angiography (using Triurol) (ab), Torgny Greitz, June, 882
- serial angiographic study of circulatory dynamics of brain (ab), E. Woringer et al, May, 756
- some factors influencing non-visualization of internal carotid artery by angiography (ab), Norman H. Horwitz and Rembrandt H. Dunsmore, Jan., 122
- spontaneous occlusion of middle cerebral artery (ab), Emanuel H. Feiring and Bernard J. Sussman, June, 884
- surgical treatment of arteriovenous malformations of brain (ab), Robert A. Hayne et al, March, 435
- transient herniation of brain as revealed by displacement of arteries (ab), Antony Jefferson and Philip Sheldon, May, 760
- utilization of total simultaneous cerebral angiography by intravenous route in child (ab), Ch. Pheline et al, May, 755
- vertebral angiography in diagnosis of hydrocephalus and differentiation between stenosis of aqueduct and cerebellar tumor (ab), F. Olov Lofgren, May, 757
- cysticercosis**
 - generalized cysticercosis with cerebral infestation (ab), Trevor Owen and Michael Lenczner, June, 884
- cysts**
 - parapharyngeal cyst of third ventricle (ab), Harry W. Slade and Norman M. Glazer, Jan., 122
- diseases**
 - encephalomalacia simulating the clinical and radiological aspects of brain tumor; 6 cases (ab), Giuseppe Scarcella, May, 759
- hematoma**
 - angiographic differentiation between acute and chronic subdural and extradural hematomas (ab), Olof Norman, May, 756
 - traumatic intracerebral hematoma; review of 16 surgically treated cases (ab), Robert L. McLaurin and Bert H. McBride, March, 435
- herniation**
 - tentorial herniations (ab), N. Azambuja et al, May, 760
 - transient herniation of brain as revealed by displacement of arteries (ab), Antony Jefferson and Philip Sheldon, May, 760
- roentgenography.** See Meninges; Neuralgia; other subheads under Brain
 - contribution to methods of filling posterior fossa and adjoining cervical subarachnoid space with small quantities of air (ab), H. Verbiest, June, 883
 - controlled study of cortisone therapy for headache after pneumoencephalography (ab), Orceneth A. Fly, Jr., et al, April, 600
 - positive contrast ventriculography—critical evaluation (ab), Norman H. Horwitz, May, 754
 - presence of foam in cerebrospinal fluid in encephalography (ab), F. Petrović, Jan., 122
 - retrobulbar air injection with planigraphy (ab), G. Richard Keskey and William R. Letsch, June, 886
 - two years' experiences with a cisterno-encephalographic technic (ab), M. Lenzi and G. C. Canossi, May, 759
- tumors.** See also Brain, herniation; Meninges, tumors
 - angiography and pneumography in diagnosis of slightly space-occupying supratentorial tumors (ab), I. Wickham, May, 758
 - concerning roentgen diagnosis of intracranial dermoids (so-called cholesteatoma) (ab), H. E. Schulze, Feb., 278
 - diagnostic value of encephalographic examination of subarachnoid space (in brain tumor suspects) (ab), Giovanni Ruggiero, May, 753
 - diagnostic value of functional serial angiography in intracranial lesions (ab), W. Schiefer, May, 755
 - effect of single doses of roentgen radiation on experimentally induced gliomas: with critical review of effects of roentgen radiation on gliomas in man (ab), Martin G. Netsky et al, June, 917
 - encephalography of sellar and parasellar tumors, with particular reference to anteroposterior projection and olfactory sulci (ab), Joseph Hanelin and Louis Bakay, May, 754
 - encephalomalacia simulating clinical and radiological aspects of brain tumor; 6 cases (ab), Giuseppe Scarcella, May, 759
 - phlebography in tumors of hemispheres and central gray matter (ab), E. Laine et al, May, 757
 - pinealoma with metastases in central nervous system: rationale of treatment (ab), Fred D. Fowler et al, March, 462
 - repeated angiographic examinations during roentgen therapy (ab), A. Breit and J. Peiffer, May, 757
 - results of radiotherapy, 1945-1954 (ab), Hellmut Schwenken-becher, May, 785
 - roentgenographic signs of tumors of brain (ab), Eva L. Gilbertson and C. Allen Good, June, 884
 - scintiscanning as method for localization of tumors (especially gliomas) (ab), Robert L. Bell et al, May, 758
 - vertebral angiography in supratentorial expansive processes (ab), F. Columella and I. Papo, May, 758
- wounds and injuries.** See also Brain, hematoma
 - blood volume changes in cases of cerebral trauma as determined by radioactive isotopes (ab), Edmund A. Smolik et al, Jan., 152
- BRAUN, J. P.** See WORINGER, E.
- BREAM, CHARLES A., and SPRUNT, WILLIAM H., III:** An unusual cystic lesion of bone, limited to the pelvis and lower extremities. Osteogenesis imperfecta cystical? Feb., 179
- BREAST**
 - study of lymphatics of mammary gland with radioactive gold (Au^{198}) (ab), Felix E. Leborgne et al, March, 470
- cancer.** See also Tumors, experimental
 - can mass x-ray surveys be used in detection of early cancer of breast? (ab), J. Gershon-Cohen et al, May, 771
 - periodic roentgenographic studies of a growing human mammary cancer (ab), Helen Ingleby and Lolita Moore, June, 894
 - radioactive gold in malignant effusion (ab), Owen Millar and J. C. F. MacDonald, March, 470
 - surgical and radiation treatment of carcinoma; new concept (use of radiophosphorus) (ab), Bertram V. A. Low-Beer and H. Glenn Bell, April, 619
- BREIT, A., and PEIFFER, J.:** Repeated angiographic examinations during roentgen therapy of brain tumors (ab), May, 757
- BREITNER, J., and ROTH, W.:** Importance of the intestinal flora in the radiation treatment of gynecological carcinomata (ab), April, 621
- BREM, THOMAS H.** See ISAAC, FRANK
- BRETT, G. Z., BENJAMIN, B., CRAIG, J. WALLACE, and FREEMAN, V.:** Static mass radiography in a London borough (ab), Jan., 125
- BRISTOL, LEONARD J.:** Radiological diagnosis of obstructive emphysema (ab), May, 763
- BRISTOW, J. D., and GAULDEN, E. C.:** Three cases of circumscribed pulmonary opacities simulating tumor (ab), May, 765
- BRODIE, MARVIN.** See BERK, J. EDWARD
- BRODNY, M. L., and ROBIN, S. A.:** Urethrocytographic classification of prostatitis (ab), March, 459
- BROFMAN, BERNARD L.:** Intracardiac angiography: controlled instantaneous intra-atrial release of contrast material in man (ab), May, 767
- BROMBART:** Definition, distribution, and roentgenologic aspects of esophageal diverticula (ab), Feb., 289
- BRONCHI**
 - See also Bronchiectasis; Fistula
 - dose to trachea and bronchi from decay products of radon and thoron (ab), A. C. Chamberlain and E. D. Dyson, April, 633
- calcification**
 - broncholithiasis; review of 27 cases (ab), Laurence K. Groves and Donald B. Effler, Jan., 128
- cancer.** See also Lungs, cancer
 - bronchogenic carcinoma and pulmonary tuberculosis; problems in diagnosis with special reference to antituberculous chemotherapy (ab), Herman Weissmann, June, 888
 - carcinoma; effect of radiotherapy on survival (ab), J. R. Bignall, May, 786
 - focal carnivoring necrotizing pneumonia and its differentiation from carcinoma of bronchus (ab), E. Zdzansky, May, 763
 - grid therapy of carcinoma (ab), Ernst Kahr, May, 786
 - influence of histologic type on survival following radiotherapy of bronchogenic carcinoma (ab), Eugene R. Kutz, June, 908
- diseases**
 - chronic bronchitis, emphysema, and bronchial spasm in bituminous coal workers; epidemiological study (ab), John Pemberton, May, 763
- obstruction**
 - large pneumothorax and associated massive collapse of homolateral lung due to intrabronchial obstruction; case (ab), Sidney W. Nelson, March, 411
- roentgenography.** See also other subheads under Bronchi
 - bronchography with new contrast media (iodized oil thickened with sulfanilamide and Dionosil Oily); review (ab), Sheldon E. Domm et al, June, 887

BRONCHI, roentgenography—cont.

- correlated bronchographic and histopathologic study of bronchial disease in 216 tuberculous patients (ab), Raymond F. Corpe and Eugene C. Hwa, March, 437
- evaluation of 3,5-diiodo-4-pyridone N-acetic acid (Dionosil) as bronchographic agent (ab), H. G. Boren and D. V. Miller, June, 888
- roentgenologic method for demonstration of bronchopulmonary segments in fully expanded cadaver lungs in situ (ab), Kuo-York Chynn and L. R. Sante, Feb., 280
- selective angiopneumography and correlative study of bronchography and histopathologic findings in tuberculous fibrothorax (ab), Raúl Cicero et al., Jan., 124
- use of Viscidol, in bronchography, Samuel Cohen, Harry J. Perlberg, and C. R. Larde-Arthez, Feb., 197

tumors

- note on roentgen features of bronchial adenoma of peripheral type, Irwin Bluth, Feb., 193
- primary sarcoma of bronchus and lung (ab), Lew A. Hochberg and Philip Crastopol, June, 889

BRONCHIECTASIS

- experimental production in dogs (ab), Jacques Delarue and René Abelanet, April, 602
- fate of children with bronchiectasis (ab), Christopher Strang, April, 602
- Kartagener's syndrome; case (ab), E. Finkler, March, 460
- Kartagener's syndrome in newborn infant (ab), Samuel J. Nichamin, May, 766
- Kartagener's triad (situs inversus, bronchiectasis, and sinusitis); case (ab), David L. Deutsch, June, 891
- reversal of advanced bronchiectasis, John R. Pontius and Lewis G. Jacobs, Feb., 204
- role of sinusitis in bronchiectasis (ab), R. M. Versteegh and J. Swierenga, June, 891

BRONCHOGRAPHY. See Bronchi**BRONCHOLITHIASIS. See Bronchi, calcification****BROOKES, V. S. See THORN, P. A.****BROOKS, PHILLIPS M.: Prompt effects of whole-body irradiation at a high dose rate on the electroencephalogram of monkeys (ab), March, 475****—GERSTNER, HERBERT B., and SMITH, SIDNEY A.: Early vasoconstriction induced in the isolated rabbit's ear by x-radiation (ab), April, 635****BROOKS, FRED, and MILLER, J. E.: Infantile cortical hyperostosis (ab), April, 611****BROTHERS, MILTON. See SIEGEL, ELSIE P.****BROWN, CHARLES H., and ALBRIGHT, C. PETER: Achalasia of the cardia and mega-esophagus. Report of five representative cases (ab), May, 772****—See INTIERE, ANTHONY D.****—MOBERG, CARL H., and EFFLER, DONALD B.: Compound diaphragmatic hernia: report of five cases (ab), Jan., 137****—See STRITTMATTER, W. C.****BROWN, D. E. MEREDITH. See BATTEN, RICHARD****BROWN, DAVID B., and THORSON, THEODORE A.: Reticulum-cell sarcoma of rats. Apparent inhibition by x-irradiation (ab), Feb., 313****BROWN, J. SCOTT, and MIDDLEMISS, J. H.: Bone changes in tropical ulcer (ab), Feb., 296****BROWN, JAMES W., HEATH, DONALD, and WHITAKER, WILLIAM: Epstein's disease (ab), Jan., 129****BROWN, MARY B. See CARNES, WILLIAM H.****—See HIRSCH, BARBARA B.****—See KAPLAN, HENRY S.****BROWNING, CARROLL W.: An evaluation of beta irradiation therapy in ophthalmology (ab), April, 622****BRUCE, W. R., and JOHNS, H. E.: Monte Carlo calculations on the spectrum of scattered radiation produced in water by x-ray beams of interest in radiotherapy, Jan., 100****BRUCE, W. R., and JOHNS, H. E.: Monte Carlo calculations on the spectrum of scattered radiation produced in water by x-ray beams of interest in radiotherapy, Jan., 100****BRUCE, W. R., and JOHNS, H. E.: Monte Carlo calculations on the spectrum of scattered radiation produced in water by x-ray beams of interest in radiotherapy, Jan., 100****BRUCE, W. R., and JOHNS, H. E.: Monte Carlo calculations on the spectrum of scattered radiation produced in water by x-ray beams of interest in radiotherapy, Jan., 100****BRUCE, W. R., and JOHNS, H. E.: Monte Carlo calculations on the spectrum of scattered radiation produced in water by x-ray beams of interest in radiotherapy, Jan., 100****BRUCE, W. R., and JOHNS, H. E.: Monte Carlo calculations on the spectrum of scattered radiation produced in water by x-ray beams of interest in radiotherapy, Jan., 100****BRUCE, W. R., and JOHNS, H. E.: Monte Carlo calculations on the spectrum of scattered radiation produced in water by x-ray beams of interest in radiotherapy, Jan., 100****BRUCE, W. R., and JOHNS, H. E.: Monte Carlo calculations on the spectrum of scattered radiation produced in water by x-ray beams of interest in radiotherapy, Jan., 100****BRUCE, W. R., and JOHNS, H. E.: Monte Carlo calculations on the spectrum of scattered radiation produced in water by x-ray beams of interest in radiotherapy, Jan., 100****BRUCE, W. R., and JOHNS, H. E.: Monte Carlo calculations on the spectrum of scattered radiation produced in water by x-ray beams of interest in radiotherapy, Jan., 100****BRUCE, W. R., and JOHNS, H. E.: Monte Carlo calculations on the spectrum of scattered radiation produced in water by x-ray beams of interest in radiotherapy, Jan., 100****BRUCE, W. R., and JOHNS, H. E.: Monte Carlo calculations on the spectrum of scattered radiation produced in water by x-ray beams of interest in radiotherapy, Jan., 100****BRUCE, W. R., and JOHNS, H. E.: Monte Carlo calculations on the spectrum of scattered radiation produced in water by x-ray beams of interest in radiotherapy, Jan., 100****BURGERMAN, ARTHUR, BAGGENSTOSS, ARCHIE H., and CAIN, JAMES C.: Primary malignant neoplasms of the duodenum, excluding the papilla of Vater. A clinicopathologic study of 31 cases (ab), Jan., 132****BURR, R. C. See BERRY, N. E.****BUSH, J. A., MAHONEY, J. P., GUBLER, C. J., CARTWRIGHT, G. E., and WINTROBE, M. M.: Studies on copper metabolism. XXI. The transfer of radio-copper between erythrocytes and plasma (ab), March, 472****BUSHUEFF, BORIS. See JORESS, MARK H.****C****CADAVERS**

- roentgenologic method for demonstration of bronchopulmonary segments in fully expanded cadaver lungs in situ (ab), Kuo-York Chynn and L. R. Sante, Feb., 280

CAFFEY, JOHN, honored, Jan., 109**CAFFEY, JOHN, AMES, ROSE, SILVERMAN, WILLIAM A., RYDER, CHARLES T., and HOUGH, GARY: Contradiction of the congenital dysplasia-predislocation hypothesis of congenital dislocation of the hip through a study of the normal variation in acetabular angles at successive periods in infancy (ab), March, 455****—and ROSS, STEVEN: Mongolism (mongoloid deficiency) during early infancy—some newly recognized diagnostic changes in the pelvic bones (ab), March, 456****CAIN, JAMES C. See BURGERMAN, ARTHUR****CAISSON DISEASE**

- roentgen manifestations (ab), Maxwell H. Poppel and William T. Robinson, May, 779

CALCIFICATION. See Adrenals; Aneurysm, splenic; Aorta; Syphilis; Appendix; Bronchi; Kidneys; Lymph Nodes; Stomach; cancer, etc.**CALCINOSIS. See Kidneys****CALCIUM. See Blood, calcium; Radioactivity, radiocalcium****CALCULI. See Bile Ducts; Gallbladder; Salivary Glands****CALDECOTT, RICHARD S.: Effects of hydration on x-ray sensitivity in Hordeum (ab), March, 475****CAMERMAN, J.: Roentgenographic examinations and radiation hazard (ab), Jan., 153****CAMERON, BRUCE M.: Osteochondritis dissecans of the ankle joint. Report of a case simulating a fracture of the talus (ab), May, 784****CAMPBELL, J. E. See ANTONY, D. S.****CAMPBELL, JAMES L. See THOMLEY, MILES W.****CAMPUZANO, MANUEL. See FALOMIR, JOSÉ M.****CANCER**

- See also Sarcoma; Tumors, experimental; under organs and regions
- clinical fellowships, American Cancer Society, March, 427
- Seventh International Cancer Conference, April, 586

cells

- action of x-rays on mammalian cells (ab), Theodore T. Puck and Philip I. Marcus, March, 475

etiology. See also Tumors, experimental

- carcinogenesis by radioactive substances (ab), Jacob Furth and John L. Fultz, May, 791
- danger of cancer from Thorotrast as diagnostic medium (ab), Earl Budin and J. Gershon Cohen, April, 632
- radiation as carcinogenic agent (ab), Austin M. Brues, Feb., 313

experimental. See Tumors, experimental**in children**

- cancer of thyroid and irradiation (ab), Erich M. Uhlmann, April, 632

metastases. See also Bones, cancer; Lungs, cancer; Lymph Nodes, cancer

- four cases illustrating use of I^{131} in management of metastatic carcinoma of thyroid (ab), John P. Storaasli and Donald P. King, April, 628
- importance of thoracic duct in spread of malignant disease (ab), Alejandro Celis et al., Jan., 126
- mediastinal parathyroid carcinoma with metastases; report of case and review of literature, Irving Weissman, James P. Worden and James M. Christie, March, 352
- radioactive gold in malignant effusions (ab), Owen Millar and J. C. F. MacDonald, March, 470
- serum I^{131} fractionation in metastatic carcinoma of thyroid; fate of endogenous radiothyroxine after I^{131} therapy (ab), Manuel Tubis and Franz K. Bauer, Feb., 311
- telerecentigraphy in treatment of neoplastic metastases (ab), G. Nadolny, Jan., 147
- treatment of peritoneal and pleural mesothelioma and metastatic malignancy with radioactive colloidal gold (ab), F. M. Lyle and Philip S. King, April, 628
- treatment of primary and metastatic cancer of liver (ab), Irving M. Ariel, March, 464
- vaginal metastases following treatment of endometrial carcinoma (ab), Richard W. Stander, Feb., 304
- vertebral metastasis in renal carcinoma: anatomic correlation (ab), George T. Wohl, March, 454
- vertebral trephine biopsy (for determination of cancer, metastasis) (ab), Wolfgang Ackermann, March, 455

radiotherapy. See also Cancer, metastases

- augmenting effects of radiation therapy by chemotherapy and other agents (ab), Raymond R. Lanier et al., June, 910
- depth doses in roentgen grid irradiation (ab), Karl Seidel, Feb., 309

CANCER, radiotherapy—cont.

- investigations of dose distribution in grid therapy in phantom and in patient (ab), Hans-Jürgen Eichhorn and Siegfried Matschke, Feb., 309
- isotope implant therapy for internally situated tumors (ab), Paul V. Harper et al., May, 787
- pituitary radon implant for advanced cancer (ab), A. P. M. Forrest et al., March, 462
- technic for permanent implantation of radioisotopes, Ulrich K. Henschke, Feb., 256
- therapeutic use of single doses of total-body radiation (ab), Vincent P. Collins and R. Kenneth Loeffler, Jan., 148

CANDON, J. C. See BÉTOULIÈRES, P.**CANOSSE, G. C. See LENZI, M.****CANTHUS. See Eyelids****CARABALONA, P. See BÉTOULIÈRES, P.****CARBON. See Radioactivity, radiocarbon****CARBON DIOXIDE**

- improved technic for double-contrast examination of colon by use of compressed carbon dioxide, George Levene and S. A. Kaufman, Jan., 83
- in vivo visualization of intracardiac structures with gaseous carbon dioxide: cardiovascular-respiratory effects and associated changes in blood chemistry (ab), M. J. Oppenheimer et al., June, 893
- rate of elimination of labeled carbon dioxide from body (ab), Douglas R. Drury et al., June, 914

CARBON MONOXIDE

- protective action of carbon monoxide in mammalian whole-body x-irradiation (ab), Eugene B. Konecni et al., Feb., 315

CARCINOID (argentaffinoma). See Intestines, tumors**CARDIA. See Stomach****CARDIOVASCULAR SYSTEM**

- See also Aneurysm; Aorta; Heart; etc.

abnormalities

- cardiovascular changes in dystrophia mesodermalis congenita Marfan (ab), P. Amundsen and I. Holter, March, 441
- congenital anomalies of large mediastinal vessels (ab), Franco Chiariotti and Carlo Picchio, Feb., 289
- congenital vascular lesions imitating patent ductus (ab), Carl Davis, Jr., et al., March, 442
- displacements of barium-filled esophagus by cardiovascular lesions (ab), Nathaniel E. Reich and David E. Ehrlich, Feb., 286
- malignant argentaffinoma associated with cardiovascular abnormalities (ab), W. R. Eyer et al., Jan., 129

roentgenography

- angiocardigraphic mixing defects as indicators of left to right shunts (ab), Melvin M. Figley et al., April, 603
- angiocardigraphic observations of intracardiac flow in the normal and in mitral stenosis (ab), Louis A. Soloff et al., Jan., 128
- angiocardiology in intrathoracic tumors with particular reference to question of operability (ab), Per Amundsen and Edwin Sørensen, Jan., 126
- blood pressure and heart rate during angiocardiology, abdominal aortography, and arteriography of lower extremities (ab), A. K. Amundsen et al., April, 604
- buckling of carotid artery demonstrated by angiocardiology (ab), Walter Lentino et al., March, 442
- growing importance of cardiovascular radiology (ab), Fred J. Hodges, May, 767
- in vivo visualization of intracardiac structures with gaseous carbon dioxide: cardiovascular-respiratory effects and associated changes in blood chemistry (ab), M. J. Oppenheimer et al., June, 893
- physiological effect of contrast media (Neo-Iopax, Diodrast, and Urokon) used for angiocardiology (ab), George G. Rowe et al., April, 604
- position of radiology in cardiovascular diagnosis (ab), Fred J. Hodges, March, 439
- temporary arrest of contrast medium in angiocardiology (ab), Alejandro Celis et al., March, 443

CARDON, ORSON P. See SCHLUGER, JOSEPH**CARLSON, KENNETH E. See ROBERTS, JAMES C., Jr.****CARMAN LECTURE. See Radiological Society of North America****CARNES, WILLIAM H., KAPLAN, HENRY S., BROWN, MARY B., and HIRSCH, BARBARA B.: Indirect induction of lymphomas in irradiated mice. III. Role of the thymic graft (ab), May, 794****—See KAPLAN, HENRY S.****CARNESALE, PETER L., and STEGMAN, KENNETH F.: Blastomycosis of bone. Report of four cases (ab), June, 898****CAROTHERS, E. L. See HAHN, P. F.****CAROTID ARTERY. See Arteries****CARROLL, DAVID S. See BRADY, BOYER M.****CARROLL, ROBERT E., GODWIN, JOHN T., and WATSON, WILLIAM L.: Osteogenic sarcoma of phalanx after chronic roentgen-ray irradiation (ab), June, 915****CARTER, JOHN H., DICKERSON, ROBERT, and NEEDY, CARL: Angiosarcoma of bone: a review of the literature and presentation of a case (ab), May, 778****CARTER, E. E., BOND, V. P., and SEYMOUR, P. H.: Relative biological effectiveness of fast neutrons in mice (ab), April, 634****—See BOND, V. P.****CARTILAGE**

- autoradiographic study of organically bound carbon-14 in growing epiphyseal cartilage and bone (ab), Richard C. Greulich, April, 632
- juxtacortical chondroma (ab), Henry L. Jaffe, April, 610

CARTWRIGHT, G. E. See BUSH, I. A.**del CASTILLO, HERMILO. See CELIS, ALEJANDRO****—See CICERO, RAÚL****CASWELL, R. S.: Neutron-insensitive gamma-ray dosimeter, Jan., 101****CATHETERIZATION. See Arteries, pulmonary; Heart****CATHODE RAYS. See Electrons****CATZ, BORIS, and STARR, PAUL: Cancer of the thyroid, with metastases to the lungs. Condition shown by scintigram in absence of definite x-ray findings (ab), Jan., 150****CAVE, P., BURFIELD, G. A., and RANKIN, J. A.: Report on 1028 cases of intravenous urography with sodium aceto-zoate (Diagnol) as contrast medium (ab), Jan., 142****CEBALLOS, JORGE. See SCHNEIDER, MARTIN****CECUM****perforation**

- roentgen criteria of impending perforation, Leonard Davis and Robert M. Lowman, April, 542

volvulus. See Intestines, volvulus**CELIS, ALEJANDRO, CICERO, RAÚL, del CASTILLO, HERMILO, and ARCE G., ENRIQUE: Temporary arrest of the contrast medium in angiocardiology (ab), March, 443****—KUTHY, JOSÉ, and del CASTILLO, HERMILO: The importance of the thoracic duct in the spread of malignant disease (ab), Jan., 126****CELLS. See Cancer, cells****CEMBER, H., HATCH, T. F., WATSON, J. A., GRUCCI, T., and BELL, P.: The elimination of radioactive barium sulfate particles from the lung (ab), May, 796****CEREBELLUM**

- effects of acute x-irradiation on evoked cerebellar response (ab), John C. Lee et al., Feb., 315

tumors

- unusual case of Lindau's disease. Cystic disease of kidneys and pancreas with renal and cerebellar tumors (hemangioblastoma) (ab), Frank Isaac et al., March, 460
- vertebral angiography in diagnosis of hydrocephalus and differentiation between stenosis of aqueduct and cerebellar tumor (ab), F. Olov Löfgren, May, 757

CEREBROSPINAL FLUID

- presence of foam in cerebrospinal fluid in encephalopathy (ab), F. Petrović, Jan., 122
- transfer of potassium between blood, cerebrospinal fluid and brain tissue (ab), Guilford G. Rudolph and Norman S. Olsen, May, 789

CEREBRUM. See Brain**CERTA, H., and HEITE, H.-J.: On the spreading effect of x-rays as measured by intradural pressure (ab), Jan., 155****CESIUM. See Radioactivity, radiocesium****CHALEK, C. C. See WOODRUFF, J. H., Jr.****CHAMBERLAIN, A. C., and DYSON, E. D.: Dose to the trachea and bronchi from the decay products of radon and thoron (ab), April, 633****CHAMBERLAIN, RICHARD H. See TRISTAN, THEODORE A.****CHAMBERLAIN, W. EDWARD. See RATTNER, HERBERT****CHAPMAN, JOHN S.: Tuberculosis in infants and children. A review (ab), Jan., 123****CHAPMAN, SAMUEL B.: Radiologic evaluation of chest lesions in children (ab), April, 603****—See LOCKWOOD, IRA H.****CHAPMAN, WILLIAM H., and JEROME, EDWARD A.: An analysis of the effects of total-body x-irradiation on body weight of white Swiss mice. II. Body-weight changes of male mice as a biological dosimeter (ab), April, 633****CHARBENEAU, HAROLD P. See MARTNER, EDGAR E.****CHARCOAL**

- stable, low-background, high-efficiency scintillation counter for analysis of low levels of radon concentrated by adsorption on charcoal, H. F. Lucas, Jr., Feb., 258

CHARR, ROBERT: Pulmonary changes in welders. Report of three cases (ab), April, 602**CHAUDHURY, D. C. ROY. See KONAR, N. R.****CHEMICALS AND CHEMOTHERAPY**

- augmenting effects of radiation therapy by chemotherapy and other agents (ab), Raymond R. Lanier et al., June, 910
- bronchogenic carcinoma and pulmonary tuberculosis; problems in diagnosis with special reference to antituberculous chemotherapy (ab), Herman Weissman, June, 888

CHEN, IRENE. See FULLER, JOHN B.**CHERIGIE, E.: Radiology of the inflamed small intestine. Functional and organic signs of inflammatory disease (ab), Jan., 133****CHERUBISM. See Jaws****CHEST. See Thorax****CHEVROT, L. See PHELINE, CH.****—See VIALLET, P.****CHIARIOTTI, FRANCO, and PICCHIO, CARLO: Congenital anomalies of the large mediastinal vessels (ab), Feb., 289****CHIAT, HAROLD. See LOITMAN, BERNARD S.****CHILDREN**

- See also Bones, pathology; Cancer, in children; Heart, abnormalities; Hip, dislocation; Infants, Newborn; Infants, Premature; Intussusception; Tuberculosis, in children

CHILDREN—cont.

- acute hematogenous osteomyelitis (in 99 children) (ab), Morris Green et al, Jan., 138
- arteriovenous aneurysm of posterior fossa in an infant: case (ab), E. C. Schultz and William A. Huston, Jan., 121
- developmental changes of skull as seen on roentgenograms (ab), K. H. Schiffer, May, 760
- dysplasia epiphysealis multiplex; case in Bantu child (ab), E. Cope et al, May, 779
- secretory pyelography in infants; technic for intravenous injection (ab), Edward B. Singleton and Gunyon H. Harrison, March, 458
- familial dysautonomia: pulmonary manifestations (ab), Ralph E. Moloshok and John E. Moseley, Jan., 127
- fate of children with bronchiectasis (ab), Christopher Strang, April, 602
- fractures of spine in children (ab), Otto Lehmann, April, 611
- incidence of spina bifida occulta in relation to age (ab), Wataru W. Sutow and Arthur W. Pryde, Jan., 139
- mediastinal tumors in children (ab), Edward B. Singleton and E. Wiley Biles, June, 801
- multiple skeletal lesions in young children due to trauma (ab), Harry Bakwin, May, 777
- neuroblastomas in infancy and childhood; review of 10 years experience (ab), C. W. Reiquam et al, April, 621
- non-specific spondylitis in children (ab), H. Wissler, April, 612
- Pneumocystis carinii pneumonia in infant (ab), Georges Dauzier et al, June, 800
- polycystic disease of kidney in infants; nephrograms following intravenous urography (ab), C. I. Hinkel and L. C. Santini, May, 784
- presence of foam in cerebrospinal fluid in encephalography (ab), F. Petrović, Jan., 122
- radiologic evaluation of chest lesions in children (ab), Samuel B. Chapman, April, 603
- recurrent pulmonary hemorrhage with hemosiderosis: so-called idiopathic pulmonary hemosiderosis (ab), André J. Bruwer et al, May, 766
- renal tubular disease with nephrocalcinosis; 2 unusual cases (ab), J. A. James, April, 615
- roentgen study of spinal cord tumors in children (ab), J. Lefebvre et al, May, 784
- roentgenographic manifestations of congenital megacolon (Hirschsprung's disease) in early infancy (ab), Carroll Z. Berman, June, 896
- role of irradiation in treatment of Wilms' tumor in children (ab), H. Dabney Kerr and Robert E. Flynn, March, 465
- significance of digital impressions in children's skulls (ab), George du Boulay, May, 759
- simple approach to roentgen diagnosis of abdominal tumors in infants and children (ab), Charles M. Nice, Jr., et al, March, 459
- simple instrument for urethrocytography and fistulography in adults and children (ab), Åke Gullmo, April, 616
- some rare causes of vomiting in infancy and childhood (ab), S. P. Rawson, March, 460
- subdural collections of fluids in infants and children. II. Study with radioactive sodium phosphate (P^{32}) (ab), R. M. N. Crosby and Robert E. Bauer, Jan., 121
- utilization of total simultaneous cerebral angiography by intravenous route in child (ab), Ch. Pheline et al, May, 755
- vertebral changes in childhood leukemia, Bernard S. Epstein, Jan., 65
- CHILDS, DONALD S., Jr.** See WILLIAMS, MARVIN M. D.
- CHILDS, WESLEY A.** See SPENSLEY, ROBERT D.
- CHIN, E. F., and LYNN, R. B.:** Surgery of eventration of the diaphragm (ab), May, 772
- CHLORPROMAZINE HYDROCHLORIDE**
 - new drugs for irradiation sickness, Basil A. Stoll, March, 380
- CHOANAE.** See Nose
- CHOLANGIOGRAPHY.** See Biliary Tract
- CHOLECYSTITIS.** See Gallbladder
- CHOLECYSTOGRAPHY.** See Gallbladder, roentgenography
- CHOLEGRAPHY.** See Gallbladder, roentgenography
- CHOLESTEATOMA.** See Tumors, cholesteatoma
- CHOLEGRAFIN.** See Biliary Tract; Eyes; Gallbladder
- CHONDROMA.** See Tumors, chondroma
- CHRISTENSEN, WM. R., and WARNER, ROBERT S.:** The A-V lecthe kit, March, 415
- CHRISTIE, JAMES M., and WEISSMAN, IRVING**
- CHRISTOPHERSON, WILLIAM M., and BERG, HAROLD F.:** A histopathologic study of lymph nodes irradiated with colloidal Au^{198} (ab), Feb., 311
- CHROMIUM.** See Radioactivity, radiochromium; Radioactivity, radiophosphorus
- CHYNN, KUO-YORK, and SANTE, L. R.:** Roentgenologic method for demonstration of bronchopulmonary segments in fully expanded cadaver lungs in situ (ab), Feb., 280
- CIAN, LOUIS G.** See DAVIS, HUGH J.
- CICERO, RAÚL, del CASTILLO, HERMILO, FERNÁNDEZ, MARTHA, and MOULÓN, MARIO:** Selective angiopneumography and a correlative study of bronchography and the histopathologic findings in tuberculous fibrothorax (ab), Jan., 124
- See CELIS, ALEJANDRO
- CIFARELLI, FRANCISCO P.:** Radiological diagnosis of hydatidosis (ab), June, 905
- CINERADIOGRAPHY**
 - cerebral cineangiography with image intensifier (ab), H. Verbiest and J. Feddema, June, 907
- CIRCULATION.** See Blood, circulation; Brain, blood supply; Lungs, blood supply; etc.
- CIRRHOSIS.** See Liver, cirrhosis
- CISTERNS, CEREBRAL.** See Meninges
- CITRIN, LESTER I.** See FISHMAN, ROBERT
- CIVIL DEFENSE.** See Atomic Bomb and Atomic Energy
- CLAGETT, O. THERON.** See JACKSON, ROBERT C.
- See WEED, LYLE A.
- See ZIMMER, JAMES F.
- CLARK, JOHN M.** See KOCH, RICHARD
- CLARKE, JOHN W.** See VOGEL, HOWARD H., Jr.
- CLARKE, B. G., GOADE, WILLIAM J., Jr., RUDY, HAROLD L., and ROCKWOOD, LAWRENCE:** Differential diagnosis between cancer and solitary serous cyst of the kidney (ab), April, 615
- CLATWORTHY, H. WILLIAM, Jr., HOWARD, WILLIAM H. R., and LLOYD, JAMES:** The meconium plug syndrome (ab), March, 448
- CLAUSEN, EDWIN G.** See PETERSON, H. HARVEY
- CLAVICLE**
 - duplication of clavicle ("os subclaviculare"), Charles R. Golthamer, April, 576
- CLAYTON, RALPH S., Sr.:** Carcinoma of the cervix uteri: ten-year study with comparison of results of irradiation and radical surgery, Jan., 74
- CLETSON, RICHARD W.** See LEWIS, EVAN L.
- CLEVE, EDWARD A.** See HENSLE, NESTOR M.
- COBALT.** See Radioactivity, radiocobalt
- COCCIDIOIDOMYCOSIS**
 - chronic benign residuals of coccidioidomycosis (ab), Nestor M. Hensler and Edward A. Cleve, May, 765
 - coccidioidomycosis; review and presentation of 100 consecutively hospitalized patients (ab), Denis J. O'Leary and Francis J. Curry, Feb., 284
- COCHRANE, A. L., and MIAL, W. E.:** Factors influencing the radiological attack rate of progressive massive fibrosis (ab), March, 438
- COHAN, BRUCE E.:** Aqueous humor outflow: an experimental study using radiopaque materials. I. Paracentesis technique, response evoked, and demonstration of pathway of outflow (ab), May, 762
- COHEN, E. M.** See KREMENS, V.
- COHEN, JEROME.** See SILVERMAN, FREDERIC N.
- COHEN, JONATHAN.** See LOONEY, W. B.
- COHEN, SAMUEL, PERLBERG, HARRY J., and LARDE-ARTEZ, C. R.:** The use of Viscidol in bronchography, Feb., 197
- COHEN, SIDNEY.** See WESSLER, STANFORD
- COLE, E. R.** See STEWART, H. B.
- COLE, JACK W., KROHMER, JACK, BONTE, FREDERICK J., and SCHATTEN, WILLIAM:** An experimental study of intrahepatic distribution of portal blood (ab), March, 468
- COLEMAN, JAMES L.** See SINGLETON, A. O., Jr.
- COLEY, BRADLEY L.** See CRUZ, MIGUEL
- COLLER, J. S.:** A new method of the measurement of objects by x-rays with special reference to pelvimetry (ab), June, 906
- COLLINS, VINCENT P., and LOEFFLER, R. KENNETH:** Therapeutic use of single doses of total body radiation (ab), Jan., 148
- COLLODI, GEORGE A.** See GIESELMAN, RALPH V.
- COLON**
 - See also Intestines
 - acute pancreatitis; preliminary investigation of new radio-diagnostic sign (transverse colon "cut-off" sign) (ab), Charles Stuart, May, 773
 - positional relation of gallbladder to hepatic flexure (ab), Harold G. Jacobson et al, May, 773
 - significance of ureteral studies in surgery of colon and rectum (ab), H. E. Bacon and L. McCrea, March, 458
- cancer**
 - negative x-ray report (ab), Gordon S. Ramsay, March, 448
- cysts**
 - pneumatosis involving left side of colon (ab), Richard H. Marshak et al, June, 897
 - pneumatosis coli (ab), Richard H. Marshak and Joan Eliasoph, Jan., 133
- dilatation**
 - roentgenographic manifestations of congenital megacolon (Hirschsprung's disease) in early infancy (ab), Carroll Z. Berman, June, 896
- hernia.** See Hernia, inguinal
- roentgenography.** See Colon, cancer; Intestines, roentgenography
- tumors**
 - lymphosarcoma of large bowel (ab), Martins da Silva, May, 773
 - volvulus. See Intestines, volvulus
- COLUMELLA, F., and PAPO, L.:** Vertebral angiography in supratentorial expansive processes (ab), May, 758
- COMARR, A. ESTIN:** Position of the patient for roentgenologic interpretation of proctogram (ab), March, 450
- COMBE, P.** See PHELINE, CH.
- See VIALLET, P.
- COMROE, JULIUS H., Jr.** See BARDEN, ROBERT P.
- COMSTOCK, GEORGE W.:** Tuberculosis studies in Muscogee County, Georgia. V. Tuberculosis mortality during seven years after a community-wide survey (ab), Jan., 124
- CONARD, ROBERT A.:** Some effects of ionizing radiation on the physiology of the gastrointestinal tract: a review (ab), June, 916

CONCRETE

- attenuation of 86- and 176-MEV synchrotron x-rays in concrete and lead (ab), William Miller and Robert J. Kennedy, April, 636

CONGDON, C. C., MCKINLEY, T. W., Jr., SUTTON, H., and URSO, P., Jr.: Effect of transfusions of blood showing extreme leukocytosis on survival of x-irradiated mice (ab), April, 634

CONGRESS OF RADIOLOGY AND ELECTROLOGY OF LATIN CULTURE (Fourth), Jan., 109

CONIGLIO, JOHN G., MCCORMICK, DONALD B., and HUDSON, GRANVILLE W.: Biosynthesis of fatty acids in liver and intestine of intact normal, fasted and x-irradiated rats (ab), April, 635

CONLEY, JOHN J.: Skin replacement for severe radiation dermatitis of the face (ab), March, 475

CONTAMINATION

- case of accidental puncture contaminated with Th²³². Studies on elimination and residual body activity, P. F. Gustafson, L. D. Marinelli and E. A. Hathaway, March, 358

- medical care of wounds contaminated with radioactive materials (ab), Asher J. Finkel and Earl A. Hathaway, March, 476

CONTE, F. P. See **UPTON, A. C.**

CONTRAST MEDIA

- See also Barium; Bronchi, roentgenography; Cardiovascular System, roentgenography; Gallbladder, roentgenography; Iodine and Iodine Compounds; Pyelography; etc.

- contrast medium injury to spinal cord produced by aortography; pathologic anatomy of experimental lesion (ab), G. Margolis et al, May, 770

CONWAY-HUGHES, J. H. L.: Oesophageal reflux. An analysis of 453 consecutive barium meal examinations (ab), April, 607

COOK, ELLSWORTH B. See **ELLINGER, FRIEDRICH**
COOPER, JOHN A. D. See **BULLLEY, GEORGE J.**
COOPER, MILTON, and OWEN, CHARLES A., Jr.: Labeling human erythrocytes with radiochromium (ab), March, 472

COPE, E., MORRIS, C., and GETZ, S. H.: Dysplasia epiphysealis multiplex. Report of a case in a Bantu child (ab), May, 779

COPE, JEROME A. See **SHEK, JOHN L.**

COPPER

- studies on copper metabolism. XXI. Transfer of radio-copper between erythrocytes and plasma (ab), J. A. Bush et al, March, 472

COPROLITHS. See **FECES**

CORMACK, D. V. See **SKARSGARD, L. D.**

CORNEA

- clinical experiences (especially with lesions of cornea) with strontium 90 applicator (ab), Eugene F. Lutterbeck and Irvin F. Hummon, Jr., Jan., 152

CORNWELL, WILLIAM S., and RAMSEY, GEORGE H.: Unusual bilateral sacrococcygeal ossicles, Jan., 70

CORONARY VESSELS

- method for coronary arteriography (ab), Louis M. Levy et al, March, 444

CORPE, RAYMOND F., and HWA, EUGENE C.: A correlated bronchographic and histopathologic study of bronchial disease in 216 tuberculous patients (ab), March, 437

CORRIGAN, KENNETH E. See **MARTMER, EDGAR E.**

CORSENTINO, B. See **NETSKY, MARTIN G.**

CORTISONE. See **Adrenocortical Preparations**

COUNTERS

- automatic brain scanner for use with gamma-ray-emitting isotopes, W. B. Reid and H. E. Johns, Feb., 259

- cancer of thyroid, with metastases to lungs. Condition shown by scintigram in absence of definite x-ray findings (ab), Boris Catz and Paul Starr, Jan., 150

- in vivo method for determination of cardiac output (externally positioned scintillation counter and radioiodinated human serum albumin as tracer), Robert E. Mack, Herschel J. Wells and Robert Pollack, Feb., 245

- Los Alamos human counter (ab), Ernest C. Anderson et al, March, 473

- scintillation spectrometer, measuring instrument in radiological practice (ab), Walter Kolb, June, 911

- scintiscanning as method for localization of cerebral tumors (ab), Robert L. Bell et al, May, 758

- small end-window and angle-window Geiger counters; measurement of radioactivity in intra-ocular tumors following injection of radioactive phosphorus (ab), Charles I. Thomas et al, April, 630

- stable, low background, high efficiency scintillation counter for analysis of low levels of radon concentrated by adsorption on charcoal, H. F. Lucas, Jr., Feb., 258

- transilluminator for use with curved Geiger counter; aid to localization of posterior intra-ocular tumors (ab), Charles I. Thomas and Jack S. Krohmer, April, 630

COWIE, THOMAS N.: Congenital spinal deformities of surgical importance (ab), May, 780

COX, W. F. See **HEMET, A.**

COXA PLANA. See **Osteochondritis deformans juvenilis**

COKE, WILLIAM. See **HAYNE, ROBERT A.**

CRAIG, J. WALLACE. See **BRETT, G. Z.**

CRAMER, FRITZ, and HUDSON, FRANK: Myelographically demonstrated lesions of the cervical intervertebral discs, co-existing with tumors and other causes of myelopathy (ab), May, 783

CRANIUM

See also Head

- grooved atrophy of parietal bone (ab), J. Gros, June, 885

- trigonocephaly, Paul A. Riemenschneider, June, 863

diseases

- inflammatory craniopathies. Various stages in development of theory (ab), Mario Bertolotti, Feb., 278

roentgenography. See also Cranium, tumors

- developmental changes of skull as seen on roentgenograms (ab), K. H. Schiffer, May, 760

- significance of digital impressions in children's skulls (ab), George du Boulay, May, 759

tumors

- tumor of bone of vascular origin; anatomical-radiological considerations of primary hemangioma of skull (ab), Giovanni Baldini and Luigi Ferri, April, 611

CRASNOPOL, PHILIP. See **HOCHBERG, LEW A.**

CRAWFORD, EDWARD J., Jr., ROBINSON, LEWIS S., and HORNBUCKLE, LLOYD A.: Surgery as an adjunct to irradiation therapy in carcinoma of the cervix. Preliminary report (ab), April, 620

CRAWFORD, PATRICK, MOLNAR, WILLIAM, and KLASSEN, KARL P.: Transcortical aortography (ab), May, 768

CROSBY, LEONARD GREEN (obit), May, 747

CROSBY, R. M. N., and BAUER, ROBERT E.: Subdural collections of fluid in infants and children. II. Study with radioactive sodium phosphate (P-32) (ab), Jan., 121

CROSBY, WILLIAM H., SAPP, OSCAR L., and ANDERSON, HJALMAR, Jr.: A sex difference in the response to titrated irradiation therapy (³²P) of patients with chronic granulocytic leukemia (ab), May, 788

CRUMPTON, CHARLES W. See **ROWE, GEORGE G.**

CRUZ, MIGUEL, and COLEY, BRADLEY L.: Aneurysmal bone cyst (ab), May, 777

CULVER, GORDON J., and PIRSON, HERBERT S.: Splenic artery aneurysms. Report of 17 cases showing calcification on plain roentgenograms, Feb., 217

CUMMINS, CHRISTOPHER. See **DOMM, SHELDON E.**

CUNEIFORM BONE. See **Tarsus**

CUNNINGHAM, JAMES B., and ACKERMAN, LAUREN V.: Metaphyseal fibrous defects (ab), May, 778

CUNNINGHAM, R. M. See **HILTON, GWEN**

CURRY, FRANCIS J. See **O'LEARY, DENIS J.**

CURTIS, ARTHUR C. See **JANSEN, G. THOMAS**

de CUEVELAND, E.: Concerning etiology of osseous bridges between lumbar transverse processes (ab), May, 781

CYCLIZINE HYDROCHLORIDE—new drugs for irradiation sickness, Basil A. Stoll, March, 380

CYCLOTRON. See **Neutrons; Protons**

CYSTICERCOSIS. See **Brain, cysticercosis**

CYSTINE

- disulfide reduction and release of iodide 131 following irradiation of ¹³¹I labeled proteins, Rosalyn S. Yalow and Solomon A. Berson, Jan., 100

CYSTOURTHROGRAPHY. See **Bladder; Urethra**

CYSTS

See also Biliary Tract; Bones; Kidneys; Lungs; Ulna

branchial. See **Fistula, branchial**

extradural. See **Spine, cysts**

paraphyseal. See **Brain, cysts**

D

DAHLIN, DAVID C. See **ZIMMER, JAMES F.**

DALITH, F.: Cervical oil myelography with full hyperextension of the neck. A modified technique (ab), May, 762

Systolic expansion or aorto-diastolic displacement. A roentgenographic study of left atrial movements in mitral cardiopathy (ab), Jan., 128

DALLENBACH, F. See **MOOS, W. S.**

DALY, JOHN F. See **STARK, ERNEST**

DANOWSKI, T. S. See **GIRDANY, B.**

DARK ADAPTATION. See **Roentgen Rays, fluoroscopy**

DATTA GUPTA, A. K.: Osseous metastasis of thyroid origin (ab), Feb., 296

DAUZIER, GEORGES, WILLIS, THAYER, and BARNETT, ROY N.: Pneumocystis carinii pneumonia in an infant (ab), June, 890

DAVES, MARVIN L., GOULD, DAVID M., and SCHULTZE, GUNTER: Roentgen findings in patients with high serum calcium, Jan., 48

DAVIDSON, S. WHATELY: Some anomalies of the respiratory system (ab), May, 762

DAVIES, A. G. M.: Bone changes in Kaposi's sarcoma. An analysis of 15 cases occurring in Bantu Africans (ab), May, 779

DAVIES, PAUL M.: Some diagnostic difficulties in cases with cascade stomach and chronic gastric volvulus (ab), June, 894

DAVILA, JULIO C. See **JANTON, O. HENRY**

DAVIS, CARL, Jr., FELL, EGBERT H., GASUL, B. M., and DILLON, ROBERT: Congenital vascular lesions imitating the patent ductus (ab), March, 442

DAVIS, COURTLAND H., Jr. See **FOWLER, FRED D.**

DAVIS, EDGAR W., KATZ, SOL, and PEABODY, J. WINTHROP, Jr.: Calcification within the solitary pulmonary nodule. A fallible sign of benignity (ab), June, 890

DAVIS, HUGH J., and CIAN, LOUIS G.: Positive pressure urethrography: a new diagnostic method (ab), Feb., 301

DAVIS, LEONARD, and LOWMAN, ROBERT M.: Roentgen criteria of impending perforation of the cecum, April, 542

- DEALY, JAMES B., Jr.:** Mitral-valve disease. A radiologic approach to a physiologic diagnosis (ab), March, 441
- DEAMICIS, EGILDA, and WILLIAMSON, EARLE W.:** Determination of radioiodine uptake in thyroids by two methods (ab), June, 911
- DEAN, DAVID L., ELLIS, F. HENRY, Jr., and SAUER, WILLIAM G.:** Intussusception in adults (ab), June, 895
- DEAVERS, S. See SMITH, E. L.**
- DEBOO, S. N.:** Non-malignant conditions causing dysphagia (ab), March, 445
- DEBRY, G. See HERBEUVAL, R.**
- DECKER, DAVID G. See FRICKE, ROBERT E.**
- DELEY, T. J. See MORRISON, R.**
- DEFICIENCY DISEASES**
—roentgenological findings in small intestine in 100 repatriated prisoners of war. Deficiency states and worm infestations (ab), Walter Francke, May, 773
- DEGLUTITION**
—disorders
—abnormal swallowing in central-nervous-system and neuromuscular disease (ab), Maxwell H. Poppel et al, Jan., 123
—hoarseness and painful deglutition due to massive cervical exostoses (ab), Charles V. Heck, April, 600
—non-malignant conditions causing dysphagia (ab), S. N. Deboo, March, 445
—radiology of pharyngo-esophageal region; Plummer-Vinson syndrome (ab), Victorino D'Alotto, Feb., 289
- DEHYDRATION**
—effects of hydration on x-ray sensitivity in Hordeum (ab), Richard S. Caldecott, March, 475
- DELANDTSHEER, J. M. See LAINE, E.**
- DELANDTSHEER-ARNOTT, G. See LAINE, E.**
- DELARUE, JACQUES, and ABELANET, RENE:** Experimental production of bronchiectasis in dogs (ab), April, 602
- DELPIO, B. See BALESTRA, G.**
- DENNIS, JOHN M., and BOUDREAU, ROBERT P.:** Pleuro-pulmonary tuberculosis: its roentgen manifestations, Jan., 25
- DENTISTRY**
—osteogenic sarcoma of phalanx after chronic roentgen irradiation (in dentist) (ab), Robert E. Carroll et al, June, 915
- DEPRAZ, A. See PIONNIER, R.**
- DERHAM, R. J.:** Postprimary intrathoracic tuberculosis in childhood with special reference to its sequelae (ab), June, 888
- DERIAN, PAUL S.:** Coxa plana in dizygotic male twins (ab), May, 783
- DERMATOLOGY. See Skin**
- DERMATOMYOSITIS**
—interstitial pneumonitis in dermatomyositis (ab), Edward S. Mills and William H. Mathews, Feb., 284
- DESCUNTS, P. See VIALLET, P.**
- DEUTSCH, DAVID L.:** Kartagener's triad (situs inversus, bronchiectasis and sinusitis). Report of a case (ab), June, 891
- DEVI, SAKUNTALA. See REDDY, D. J.**
- DEXTROCARDIA. See Heart, displacement**
- DIAGINOL. See Pyelography**
- DIAPHRAGM**
—See also Hernia, diaphragmatic
—surgery of eversion of diaphragm (ab), E. F. Chin and R. B. Lynn, May, 772
- DIATRIZOATE. See Pyelography**
- DIAZ BONNET, RAFAEL. See RODRIGUEZ, HECTOR F.**
- DICKERSON, ROBERT. See CARTER, JOHN H.**
- DIFRACTION ANALYSIS. See Roentgen Rays**
- DIGESTIVE SYSTEM. See Gastrointestinal Tract; Intestines; Stomach; etc.**
- DILLON, ROBERT. See DAVIS, CARL, Jr.**
- DIMANT, STEVENS, MOXON, C. P., and LEWTAS, N. A.:** Cerebral angiography in a neurosurgical service (ab), May, 754
- DIODONE. See Pyelography**
- DIODRAST. See Cardiovascular System, roentgenography; Iodine and Iodine Compounds; Kidneys**
- DIONOSIL. See Bronchi, roentgenography; Lungs, cancer**
- DIPROTIZOATE. See Pyelography**
- DISCOGRAPHY. See Spine, intervertebral disks**
- DIVERTICULA. See Appendix; Esophagus; Gallbladder**
- DOBYNS, BROWN M.:** Physiologic concepts in the diagnosis and treatment of Graves' disease (ab), March, 467
- DOEL, GEOFFREY:** Osteo-arthritis occlusion of the intervertebral foramina of the cervical spine (ab), May, 781
- DOMM, SHELDON E., WATERMAN, DAVID H., ROGERS, WILLIAM K., and CUMMINS, CHRISTOPHER:** Bronchography with new contrast media. A review (ab), June, 887
- DON, CONWAY, and MURPHY, D. J. L.:** Some difficulties in the diagnosis of carcinoma in the region of the cardia (ab), March, 446
- DONOVAN, CORNELIO. See AHUMADA, JUAN C.**
- DOSIMETERS AND DOSIMETRY**
—See also Electrons; Radioactivity; Roentgen Therapy; Uterus, cancer; etc.
—advances toward a stable sensitive iron dosimeter, Gail D. Adams and William R. Balkwell, Jan., 101
—analysis of effects of total-body x-irradiation on body weight of white Swiss mice. II. Body-weight changes of male mice as biological dosimeter (ab), William H. Chapman and Edward A. Jerome, April, 633
—neutron-insensitive gamma-ray dosimeter, R. S. Caswell, Jan., 101
—periodic control of function and constancy of ionization chamber dose meters (ab), R. Thoraeus, April, 623
—photographic personnel dosimeter for x-radiation in range from 30 kev to beyond 1 MEV, Margaret Ehrlich, April, 549
- DOTTER, CHARLES T.:** Teaching of chest radiology to medical students (ab), April, 603
- DOUBLEDAY, LEONARD C. See HARRISON, RICHARD H., III**
- DOUGLAS, R. GORDON. See JAVERT, CARL T.**
- DOWNING, DANIEL F.:** Congenital aortic stenosis: clinical aspects and surgical treatment (ab), June, 892
- and GOLDBERG, HARRY:** Cardiac septal defects. I. Ventricular septal defect. Analysis of one hundred cases studied during life. II. Atrial septal defect. Analysis of one hundred cases studied during life (ab), March, 439
- DRAKE, E. H. See EYLER, WILLIAM R.**
- DRURY, DOUGLAS R., WICK, ARNE N., and ALMEN, MARY CAROL:** Rate of elimination of labeled carbon dioxide from the body (ab), June, 914
- DuBOIS, KENNETH P. See SULLIVAN, MAURICE F.**
- du BOULAY, GEORGE:** Significance of digital impressions in children's skulls (ab), May, 759
- DUCTUS ARTERIOSUS**
—angiocardigraphic mixing defects as indicators of left to right shunts (ab), Melvin M. Flegley et al, April, 603
—congenital vascular lesions imitating patent ductus (ab), Carl Davis, Jr., et al, March, 442
- DUDLEY, H. C., MARKOWITZ, H. A., and MITCHELL, T. G.:** Studies of the localization of radioactive gallium (Ga^{67}) in bone lesions (ab), April, 631
- and MITCHELL, T. G.:** A study of methods for interstitial implantation of radioactive materials (ab), April, 625
- DUHAMEL, JOSEPH, and HERPE, DANIEL:** Summation image in diagnostic roentgenology (ab), March, 461
- DUNBAR, J. S.:** Fractures and pseudarthroses of the first rib (ab), April, 612
- DUNCAN, J. G.:** Radiological manifestations of hyperparathyroidism (ab), March, 460
- DUNNING, GORDON M.:** Two ways to estimate thyroid dose from radioiodine in fallout (ab), March, 468
- DUNSMORE, REMBRANDT H. See HORWITZ, NORMAN**
- DUODENUM**
—cancer
—primary carcinoma (ab), T. H. Crawford Barclay and H. P. Kent, Jan., 131
—primary carcinoma of infrapapillary portion (ab), Jacob Rabinovitch et al, June, 896
—primary malignant neoplasms of duodenum, excluding papilla of Vater; clinicopathologic study of 31 cases (ab), Arthur Burgerman et al, Jan., 132
- fistula. See Fistula**
- obstruction**
—arterioesenteric obstruction of duodenum in adult life and adolescence (ab), Erik de F. Licht, April, 608
—congenital intrinsic obstruction; 32 cases (ab), Thomas C. Moore, June, 895
—syndrome of mesenteric vascular compression of duodenum; 11 cases with operative correction (ab), Sidney A. Rosenberg and Arnold Sampson, June, 896
- roentgenography**
—anterior displacement of descending duodenum as aid in diagnosis of retroperitoneal tumor: roentgenographic sign of possible significance in some cases of enlargement of right adrenal gland (ab), Emil J. Ganem et al, Jan., 132
—duodenal loop changes in posterior penetration of duodenal ulcer (ab), J. George Teplick, March, 447
—roentgenologic findings in stomach and duodenum in cancer of pancreas (ab), Kaare A. Larsen and Arne Pedersen, April, 608
- ulcers. See Peptic Ulcer**
- DUPUYTREN'S CONTRACTURE**
—treatment (ab), Karl Wasserburger, June, 910
- DURANT, T. M. See OPPENHEIMER, M. J.**
- DURBIN, PATRICIA W., ROBERTSON, JAMES S., and HAMILTON, JOSEPH G.:** Iodine-131 beta particle dosage in small animals, Jan., 103
- DU SAULT, LUCILLE A.:** Time-dose relationships (ab), Jan., 148
- DWORKEN, HARVEY J.:** Intussusception as a cause of "disappearing" carcinoma of the rectum (ab), Feb., 293
- DYSAUTONOMIA**
—familial dysautonomia: pulmonary manifestations (ab), Ralph E. Moloshok and John E. Moseley, Jan., 127
—roentgenographic findings in familial dysautonomia, Rob H. Kirkpatrick and Conrad M. Riley, May, 654
- DYSKINESIA. See Bile Ducts**
- DYSON, E. D.:** Shoe-fitting x-ray fluoroscopes. Radiation measurements and hazards (ab), June, 915
- See CHAMBERLAIN, A. C.**
- DYSPHAGIA. See Deglutition, disorders**
- DYSPLASIA**
—epiphysialis hemimelica. See Epiphyses
—epiphysialis multiplex. See Epiphyses
—fibrous. See Bones; Jaws
—progressive diaphysial. See Bones
- DYSTROPHIA MESODERMALIS CONGENITA MARFAN.**
—See Marfan's Syndrome

DYSTROPHY, MUSCULAR

- radiologic findings in relation to severity of disease (ab), B. Girdany and T. S. Danowski, Feb., 295

E

EAGLETON, MARK D. See **SEAMAN, WILLIAM B.**

EAR

- segmental radiography of internal auditory canal in neurofibromas of eighth nerve (ab), H. Fischgold et al., May, 761

EASTCOTT, H. H. G., SUTTON, DAVID, and ROB, C. G.: Discussion on the clinical and radiological aspects of diseases of the major arteries (ab), June, 891

EASTERN CONFERENCE OF RADIOLOGISTS, Jan., 108

EBELING, P., and ROBERTSON, E. GRAEME: Meningoencephalitis due to *Brucella abortus* (ab), April, 600

EBSTEIN'S DISEASE. See **Tricuspid Valve**

ECHINOCOCCOSIS

- See also **Liver; Lungs**
- radiological diagnosis of hydatidosis (ab), Francisco P. Cifarelli, June, 905

ECKERT, EDWARD L. See **SCHOENBERGER, JAMES A.**

ECTODERMAL DEFECT

- Ellis-Creveld syndrome; case (ab), Elizabeth K. Turner, Jan., 139

EDEMA

- diagnostic possibilities of lymphangiography (ab), R. Gergely et al., June, 906

—early disappearance of ¹³¹I serum albumin from circulation of edematous subjects and its implications in clinical determination of blood volume (ab), T. W. Moir et al., March, 469

EDGREN, W., and LAURENT, L. E.: A method of measuring the torsion of the femur in congenital dislocation of the hip in children (ab), March, 456

EDGREN-SCHULTZ METHOD. See **Femur**

EDINGTON, C. W. See **STAPLETON, G. E.**

EDITORIALS

- attitudes in radiology. Presidential address: Radiological Society of North America, Clarence E. Hufford, March, 423

lymph node-fever relationship in lymphoma, Don E. Matthiesen, May, 739

on questionnaires and records, Herbert L. Abrams, June, 869

summaries in interlingua, Jan., 106

Virdee, C. Edgar, President of Radiological Society of North America, Ira H. Lockwood, Feb., 262

EDUCATION

- A-V lecture kit, Wm. R. Christensen and Robert S. Warner, March, 415

—clinical fellowships, American Cancer Society, March, 427

—course in clinical use of radioactive isotopes, Jan., 109

—course in radiology and radioactive isotopes, University of Kansas, Jan., 109

—fellowships in radiological physics, May, 742

—Freedman lectures, University of Cincinnati, March, 426

—public health traineeships, March, 427

—radioactive isotopes course, University of Southern California, March, 427

—radioiodine course, Georgetown University, March, 426

—radioisotopes course, Cook County Hospital, Chicago, March, 427

—radiologic physics course, Columbia University, March, 426

—radiological physics fellowship, Sloan-Kettering Division, Cornell Medical College, March, 427

—teaching aids for instruction in radiologic study of gastrointestinal tract (ab), H. R. Osheroff, April, 610

—teaching of chest radiology to medical students (ab), Charles T. Dotter, April, 603

—television in diagnostic roentgenology (ab), R. Janker (ab), Feb., 301

EDWARDS, JESSE E. See **BRUWER, ANDRÉ J.**

EFFLER, DONALD B. See **BROWN, CHARLES H.**

—See **GROVES, LAURENCE K.**

EFFUSIONS. See **Peritoneum; Pleura, cancer**

EHRlich, DAVID E. See **REICH, NATHANIEL E.**

EHRlich, MARGARETE: A photographic personnel dosimeter for x-radiation in the range from 30 kev to beyond 1 MeV, April, 549

Disaster monitoring with amateur photographic film and with dental x-ray film, Feb., 251

EICHORN, HANS-JÜRGEN, and MATSCHKE, SIEGFRIED: Investigations of dose distribution in grid therapy in the phantom and in the patient (ab), Feb., 309

EINHORN, J., and LARSSON, L.-G.: A lingual goiter treated with radioactive iodine (ab), March, 467

EISEN, JESSE. See **MANN, LAWRENCE S.**

EISENBERG, SANFORD H. See **NEVIASER, JULIUS S.**

ELDRIDGE, JAMES S. See **TYOR, MALCOLM P.**

ELECTROENCEPHALOGRAPHY. See **Brain**

ELECTRONS

- comparison of biological effects of whole-body irradiation with 22.5 MeV x-rays, 18-MeV electrons, and 400-kev x-rays in rat (ab), John B. Fuller et al., Feb., 315

—electron beam dosimetry of 2 MeV Van de Graaff accelerator, B. W. Shumway and R. Golden, Jan., 104

—electronic isodose computer for planning multiportal radiation therapy, featuring instantaneous display of isodose curves with continuous variability of position and fractional dose in each field, Glen Sandberg and W. S. Moos, Jan., 103

—physical measurements on a 4-MeV linear accelerator, C. A. Murison and H. A. Hughes, March, 367

—preliminary report on clinical use of Medical Research Council 8 MeV linear accelerator (ab), R. Morrison et al., Feb., 307

—Professional Group on Medical Electronics, Institute of Radio Engineers, new "affiliate" plan, March, 428

—stray radiation levels of a 45 MeV travelling wave linear electron accelerator (ab), C. L. Hsieh, Feb., 308

—time-intensity factors in radiation response. I. Acute effects of megavolt electrons (cathode rays) and high- and low-energy x-rays with special reference to brain (ab), Samuel P. Hicks et al., Jan., 154

—use of electron beams in industrial processes, E. Dale Trout, May, 708

ELIASOPH, JOAN. See **MARSHAK, RICHARD H.**

ELKINS, H. B., and KEETTEL, WILLIAM C.: Radioactive gold in treatment of ovarian carcinoma (ab), April, 628

—See **KEETTEL, WILLIAM C.**

ELLINGER, FRIEDRICH, MORGAN, JASPER E., and COOK, ELLSWORTH B.: Use of small laboratory animals in medical radiation biology. IV. Correlation of physical factors with the biological effect produced by total-body irradiation of guinea pigs (ab), June, 917

ELLIS, F. HENRY, Jr. See **DEAN, DAVID L.**

ELLIS, PAUL R. See **SPARKMAN, ROBERT S.**

ELLIS, R. E. See **FLATMAN, G. E.**

ELLIS-VAN CREVELD SYNDROME. See **Ectodermal Defect**

EMBOLISM

- air embolism during presacral pneumography; case (ab), Irving Glassman et al., Jan., 143

—temporary thrombotic state. Application of this concept to therapy of recurrent thrombo-embolism, with bacteriologic and roentgenologic considerations in the differential diagnosis of pulmonary infarction and pneumonia (ab), Stanford Wessler et al., Jan., 130

EMBRYO

- hysterothography in diagnosis of dead and retained human ovum (ab), Juan C. Ahumada et al., April, 614

EMMANUEL, RICHARD W., and PATTINSON, J. M.: Absence of the left pulmonary artery in Fallot's tetralogy (ab), May, 769

EMPHYSEMA

- acute emphysematous cholecystitis (ab), J. Kenneth Jacobs, March, 419

—chronic bronchitis, emphysema, and bronchial spasm in bituminous coal workers; epidemiological study (ab), John Pemberton, May, 763

—cystitis and urethritis emphysematosa, C. Soteropoulos, E. Kawashima and John H. Gilmore, June, 866

—radiological diagnosis of obstructive emphysema (ab), Leonard J. Bristol, May, 763

EMULSIONS, NUCLEAR

- uptake of radioiodine by thyroid cells using nuclear emulsion (ab), Adrian G. Basser, April, 627

ENCEPHALITIS. See **Meningoencephalitis**

ENCEPHALOGRAPHY. See **Brain, roentgenography; Sella Turcica**

ENCEPHALOMALACIA. See **Brain, diseases**

ENDOMETRIUM. See **Uterus, cancer**

ENEMATA. See **Intestines, roentgenography**

ENGELMANN'S DISEASE. See **Bones, diseases**

ENGELS, EDWARD P., PAULSON, E. C., and MOSSER, DONN G.: Therapy of aortic cavity effusion with colloidal radioactive gold 198 (ab), June, 913

ENGESSET, ARNFINN. See **BRUUN, SEVEN**

ENGLE, ROBERT B., JACOBSON, GEORGE, and FRASER, ELEANOR R.: Soft-tissue placentalography in diagnosis of bicornuate uterus, March, 408

ENTENMAN, C. See **KAY, R. E.**

—See **SUPPLEE, HELEN**

ENTEROCOLITIS. See **Intestines**

ENTEROLITHS. See **Appendix**

EOSINOPHILS

- chronic pulmonary infiltration with eosinophilia in the asthmatic (5 personal observations, including 1 with histopathologic analysis), (ab), J. Turial et al., Feb., 283

—solitary eosinophilic granuloma of bone (ab), T. Hunter, March, 452

EPIDERMAL. See **Brain, tumors**

EPIPHYSES

- autoradiographic study of organically bound carbon-14 in growing epiphyseal cartilage and bone (ab), Richard C. Greulich, April, 632

—dysplasia epiphysealis hemimelica (tarsal-epiphyseal aetia), Theodore E. Keats, April, 558

—dysplasia epiphysealis multiplex; case in Bantu child (ab), E. Cope et al., May, 779

—multiple epiphyseal dysplasia (ab), Edmund Shephard, March, 452

EPITHELIUM

- roentgen demonstration of movements of ciliated epithelium of trachea: experiments on isolated tracheas of slaughtered animals (ab), H. Birzle, March, 436

EPSTEIN, BERNARD S.: Vertebral changes in childhood leukemia, Jan., 65

ERYTHROCYTES

- blood volume determinations with radioactive chromium (^{Cr}51) labeled erythrocytes; feasibility of routine total red blood cell volume determinations in general hospital (ab), Leo M. Meyer, Feb., 311

ERYTHROCYTES—cont.

- determination of cell volume in massive transfusions using Fe^{59} and Cr^{51} (ab), E. L. Smith et al, May, 790
- effect of total-body x-irradiation on plasma volume, red cell volume, blood volume and thiocyanate space in normal and splenectomized rats (ab), Kee-Chang Huang and James H. Bondurant, April, 635
- isotope studies of blood flow and blood cells (ab), Edith H. Quimby, April, 624
- labeling human erythrocytes with radiochromium (ab), Milton Cooper and Charles A. Owen, Jr., March, 472
- studies on copper metabolism. XXI. Transfer of radio-copper between erythrocytes and plasma (ab), J. A. Bush et al, March, 472

ESOPHAGUS

- achalasia of cardia and mega-esophagus; 5 representative cases (ab), Charles H. Brown and C. Peter Albright, May, 772
- effect of radiation on esophagus; clinical and histologic study of effects produced by betatron, William B. Seaman and Lauren V. Ackerman, April, 534

abnormalities

- frequency of asymptomatic lower esophageal contractile ring (ab), Philip Kramer, Feb., 290
- cancer**
 - carcinoma of esophagus and gastric cardia (ab), Denis Fuller, June, 908
 - diagnostic significance of radioactive isotopes in early cancer of alimentary tract, especially esophagus and cardia (ab), Komei Nakayama, April, 630
 - difficulties in diagnosis of carcinoma in region of cardia (ab), Conway Don and D. J. L. Murphy, March, 446
 - radiation therapy of carcinoma (ab), K. Schärer, Jan., 144
 - response to irradiation; serial cytologic study of 2 cases (ab), Moshe B. Goldgraber, Feb., 302

diverticula

- definition, distribution, and roentgenologic aspects (ab), Brombart, Feb., 289
- of lower part; clinical study of 149 non-surgical cases (ab), Harold C. Habein, Jr., et al, April, 607

fatula.**See Fistula****roentgenography**

- closing mechanism of lower esophagus in man; radiological study of 500 unselected patients (ab), Maxwell H. Poppel et al, March, 445
- diagnosis and differential diagnosis of chronic supracardiac changes of lower esophagus (ab), H. Kamieth, April, 606
- displacements of barium-filled esophagus by cardiovascular lesions (ab), Nathaniel E. Reich and David E. Ehrlich, Feb., 286
- esophageal reflux; analysis of 453 consecutive barium meal examinations (ab), J. H. L. Conway-Hughes, April, 607
- radiology of pharyngo-esophageal region; Plummer-Vinson syndrome (ab), Victorino D'Alotto, Feb., 289

tumors

- co-occurrence of large leiomyoma of esophagus and squamous-cell carcinoma of thymus; case, with roentgenologic, pathologic and clinical discussion (ab), Howard A. Frank et al, May, 772
- leiomyoma (ab), Joseph Schlager et al, March, 446
- ETTINGER, ALICE, and PEREZ-TAMAYO, RUHRI:** Ulcerative jejunitis in polyarteritis, May, 669
- ETTMAN, IRVING K., BOUCHILLON, C. D., and HALFORD, H. H.:** Gastrointestinal roentgen findings due to untoward effects of hexamethonium, May, 673
- EVANS, JOHN C. See WILDERMUTH, ORLISS**
- EVANS, R. L. See AMATUZZO, D. S.**
- EVANS, TITUS C. See ROUNDS, WAYNE M.**
- EVANS, WILLIAM ALBERT (obit),** Feb., 271

EXOPHTHALMOS

- congenital defect of bony orbit and pulsating exophthalmos (ab), Hooshang Tayebi and Frederic N. Silverman, June, 886

EXOSTOSES. See Spine, exostoses**EXTREMITIES**

- lesions of bones of leg in course of varicose ulcers (ab), A. Poirault, May, 783
- unusual cystic lesion of bone, limited to pelvis and lower extremities. Osteogenesis imperfecta cystica?, Charles A. Bream and William H. Sprunt, III, Feb., 179

blood supply

- blood pressure and heart rate during angiocardiology, aortography, abdominal aortography, and arteriography of lower extremities (ab), A. K. Amundsen et al, April, 604
- clearance of radioactive iodine from lower extremities of patients with myocardial infarction (ab), Franz K. Bauer et al, May, 788
- congenital peripheral arteriovenous communications; use of femoral artery to heart circulation time in diagnosis (ab), Thomas O. Murphy et al, June, 893
- evaluation of peripheral arteriosclerotic insufficiency utilizing radioactive iodinated human serum albumin (ab), Earl J. Halligan et al, March, 468
- functional roentgenologic findings in vascular disorders (ab), Ad. Salotti and D. Lughetti, Jan., 131
- importance of translumbar aortogram and peripheral arteriogram in management of vascular disease (ab), Andrew G. Sharf et al, May, 768

fractures

- new method of measurement of objects by x-rays, with special reference to pelvimetry (and long bones) (ab), J. S. Collier, June, 906

EYELIDS

- special problem of cancer (ab), Orliiss Wildermuth and John C. Evans, June, 908
- treatment of skin tumors of inner canthus with regard to function of lacrimal ducts (ab), Hansrudolph Renfer, Jan., 143

EYES

- See also Aneurysm, ophthalmic; Cornea; Exophthalmos; Lacrimal Organs; Orbit
- aqueous humor outflow; experimental study using radio-paque materials (Urokon Sodium, Hypaque and Cholografin). I. Paracentesis technic, response evoked, and demonstration of pathway of outflow (ab), Bruce E. Cohan, May, 762
- dark adaptation with limited light and color vision, Frederic N. Silverman and Jerome Cohen, May, 733
- evaluation of beta irradiation therapy in ophthalmology (ab), Carroll W. Browning, April, 622

tumors

- small end-window and angle-window Geiger counters; measurement of radioactivity in intra-ocular tumors following injection of radioactive phosphorus (ab), Charles I. Thomas et al, April, 630
- transillumination for use with curved Geiger counter; aid to localization of posterior intra-ocular tumors (ab), Charles I. Thomas and Jack S. Krohmer, April, 630

- EYLER, WILLIAM R., TESLUCK, H., and DRAKE, E. H.:** Malignant argentaffinoma associated with cardiovascular abnormalities (ab), Jan., 129

—See KENNEY, LEO J.

- EYRE-BROOK, A. L.:** Some radiosensitive bone tumours (ab), Feb., 302

F**FABELLA DISTALIS. See Fibula****FACE. See Skin**

- FAGERBERG, STIG:** Tomographic studies on the normal and injured knee (ab), Feb., 298

- FAILLA, G.:** The flux of secondary ionizing particles in a uniformly irradiated homogeneous medium of varying density; application to walled ionization chambers (ab), Feb., 309

—See ROSSI, HARALD H.

- FALK, BENGST:** Radiologic diagnosis of intraventricular meningiomas (ab), May, 759

FALLOPIAN TUBES

- roentgen findings in genital tuberculosis in women (ab), Germaine Ratelle and Jean-Louis Léger, Jan., 140

FALLOT'S TETRALOGY. See Heart, abnormalities

- FALOMIR, JOSÉ M., CAMPUZANO, MANUEL, and SEPÚLVEDA, BERNARDO:** Splenoportography for the diagnosis of portal hypertension (ab), May, 777

- FAMILARO, JOHN E. See MANN, LAWRENCE S.**

FAMILIAL CONDITIONS**See also Heredity**

- cherubism—familial fibrous dysplasia of jaws (ab), Gy. Frigyesi, March, 436
- familial dysautonomia; pulmonary manifestations (ab), Ralph E. Moloshok and John E. Moseley, Jan., 127
- metabolism of iodotyrosines. II. Metabolism of mono- and di-iodotyrosine in certain patients with familial goiter (ab), John B. Stanbury et al, June, 912
- multiple epiphyseal dysplasia (ab), Edmund Shephard, March, 452
- roentgenographic findings in familial dysautonomia, Rob H. Kirkpatrick and Conrad M. Riley, May, 654

- FANCONI, A.:** Pulmonary adenomatosis (ab), Feb., 281

- FARIÑAS, L. MARTÍNEZ. See FARIÑAS, LAURA**

- FARIÑAS, LAURA, GÓMEZ ZALDÍVAR, RAFAEL, LLAMBES, JUAN, and FARIÑAS, L. MARTÍNEZ:** Evaluation of the different radiologic methods in the diagnosis of carcinoma of the lung (ab), June, 889

- FARRAN, HELEN E. A. See ABBATT, JOHN D.**

FASTING

- biosynthesis of fatty acids in liver and intestine of intact normal, fasted and x-irradiated rats (ab), John G. Coniglio et al, April, 635

FAT

- re-evaluation of fat-free preparatory meal in Telepaque cholecystography (ab), Walter M. Whitehouse, May, 775

- FAURÉ, C. See LEFÈVRE, J.**

FECES

- coproliths, R. M. Berg and H. M. Berg, June, 839
- evaluation of fecal recovery method for determining intestinal absorption of cobalt⁵⁷-labeled vitamin B₁₂ (ab), James A. Halsted et al, May, 790

FEDDEMA, J. See VERBIEST, H.

- FEFFER, HENRY L.:** Treatment of low-back and sciatic pain by the injection of hydrocortisone into degenerated intervertebral discs (ab), April, 612

- FEINBERG, S. B.:** Posterior mediastinal hemangioma, Jan., 90
- Roentgenographic findings in respiratory problems of infants (ab), March, 439

- and **GOLDBERG, M. E.:** Hyaline membrane disease: preclinical roentgen diagnosis. A planned study, Feb., 185

—See GREENSPAN, R. H.

- FEINBLATT, THEODORE M., and FERGUSON, EDGAR A., Jr.:** Timed-disintegration capsules. An in vivo roentgenographic study (ab), March, 460

- FEIRING, EMANUEL H., and SUSSMAN, BERNARD J.:** Spontaneous occlusion of the middle cerebral artery (ab), June, 884
- FEIST, JOHN H., and LITTLETON, JESSE T.:** Incidence of benign gastric ulcers on the greater curvature. Presentation of three cases (ab), March, 446
- FEJÉR, ROSE.** See **FOGEL, MARIE**
- FELL, EGBERT H.** See **DAVIS, CARL, Jr.**
- FELLINGER, KARL, HÖFER, RUDOLPH, and VETTER, HERBERT:** Salivary and thyroidal radioiodide clearances of plasma in various states of thyroid function (ab), Feb., 309
- FELLOWSHIPS.** See Education
- FELSON, BENJAMIN.** See **HAWLEY, CHAPIN**
- See **WISOFF, CARL P.**
- FELTON, L. R.** See **REICH, STANLEY B.**
- See **SAMPSON, J. J.**
- FEMUR**
- fracture of femoral neck following irradiation of pelvis (ab), Edgar L. Ralston, May, 790
- method (Schultz-Edgren) of measuring torsion of femur in congenital dislocation of hip in children (ab), W. Edgren and L. E. Laurent, March, 456
- prognosis and early diagnosis of non-union of femoral neck fractures by laminagraphy (ab), Norman Rosenberg et al., June, 902
- FENTON, RICHARD L.:** The naviculo-capitate fracture syndrome (ab), April, 613
- FENTON, WARD C.** See **SAWYER, KENNETH C.**
- FERGUSON, EDGAR A., Jr.** See **FEINBLATT, THEODORE M.**
- FERNÁNDEZ, MARTHA.** See **CICERO, RAÚL**
- FERRI, LUIGI.** See **BALDINI, GIOVANNI**
- FERRIS, DEWARD O., and WEBER, HARRY M.:** Evaluation of routine operative cholangiography (ab), June, 897
- FETUS**
- damage to intrauterine fetus by roentgen rays (ab), Merko Basić and Danica Weber, Feb., 312
- occurrence of free gas in fetus in cases of intra-uterine death (ab), Olov Fr. Holm, Feb., 299
- FEVER**
- lymph node-fever relationship in lymphoma (ed), Don E. Matthiessen, May, 739
- FIBROMA.** See Tumors, fibroma
- FIBROSIS.** See Lungs, fibrosis
- FIBULA**
- fabella distalis: new sesamoid bone (ab), Josef Slanina, May, 784
- FIEBELKORN, HANS-JOACHIM.** See **SCHERER, EBERHARD**
- FIELDS, THEODORE, KINNORY, DAVID S., KAPLAN, ERVIN, OESTER, Y. T., and BOWSER, EVERETT N.:** Determination of protein-bound iodine¹³¹ with anion exchange resin column (ab), March, 469
- FIGLEY, MELVIN M., NORDENSTRÖM, BJÖRN, STERN, AARON M., and SLOAN, HERBERT:** Angiocardio-graphic mixing defects as indicators of left to right shunts (ab), April, 603
- FILMS AND FILM BADGES.** See Roentgen Rays, films
- FILTERS.** See Roentgen Therapy
- FINBY, NATHANIEL.** See **MERTEN, CHARLES W.**
- See **STEINBERG, ISRAEL**
- FINDLEY, JOHN W., Jr., and THOMPSON, WILLIAM H.:** Multiple lipomas of the ileum (ab), Jan., 133
- FINGERS AND TOES**
- osteogenic sarcoma of phalanx after chronic roentgen irradiation (ab), Robert E. Carroll et al., June, 915
- FINKEL, ASHER J., and HATHAWAY, EARL A.:** Medical care of wounds contaminated with radioactive materials (ab), March, 476
- FINKLER, E.:** Kartagener's syndrome. A case report (ab), March, 460
- FISCHEDICK, O.:** Etiology and radiation treatment of the middle-lobe syndrome (ab), March, 463
- FISCHER, HARRY W.:** Colloidal stannic oxide. Animal studies on a new hepatolienographic agent, April, 488
- FISCHGOLD, H., METZGER, J., and JUSTER, M.:** Segmental radiography of the internal auditory canal in neurinomas of the eighth nerve (ab), May, 761
- FISHER, DON L.** See **FORD, WILLIAM B.**
- FISHMAN, ROBERT, and CITRIN, LESTER I.:** A new radium implant technique to reduce operating room exposure and increase accuracy of placement (ab), Jan., 150
- FISSEL, GEORGE E.:** Acute fulminating histoplasmosis (ab), June, 890
- FISTULA**
- few cases of glandular-bronchial fistula (ab), Armando Pinheiro and Fernando Outeiro, Jan., 127
- simple instrument forurethroscopy tography and fistulography in adults and children (ab), Åke Gullmo, April, 616
- arteriovenous**
- of posterior fossa in infant; case (ab), E. C. Schultz and William A. Huston, Jan., 121
- of renal vessels (caused by adenocarcinoma of kidney); case (ab), Jon R. Myhre, June, 903
- pulmonary arteriovenous aneurysm; 6 cases (ab), Ralph J. Schlosser and Henry N. Harkins, June, 893
- roentgenographic demonstration of arteriovenous fistula of renal vessels (ab), Anthony P. Gurritano et al., March, 444
- successful resections for bilateral pulmonary arteriovenous fistulas (ab), Harold A. Lyons and Edgar P. Mannix, Jr., March, 444
- biliary**
- internal biliary fistulas (ab), Oriol Arango and Augusto Marmolejo, Feb., 294
- branchial**
- branchiogenic intrathoracic mediastinothymic cyst (ab), Z. V. Skokan and J. Stolz, May, 767
- renoduodenal**
- spontaneous renoduodenal fistula (ab), John P. North et al., April, 609
- tracheoesophageal**
- congenital tracheoesophageal fistula without atresia of esophagus (ab), Richard Koch and John M. Clark, April, 606
- uretero-appendicular**
- roentgenologic findings in uretero-appendicular fistula (ab), Emo Bianchi, Jan., 141
- FLATMAN, G. E., and ELLIS, R. E.:** A report on the use of convergent beam x-ray therapy (ab), Jan., 148
- FLEISCHNER, FELIX G.** See **FRANK, HOWARD A.**
- See **WESSLER, STANFORD**
- FLOCKS, R. H.:** Treatment of urethral tumors (ab), Jan., 146
- FLUOROSCOPY.** See Roentgen Rays, fluoroscopy; Thorax
- FLY, ORCENETH A., Jr., MacCARTY, COLLIN S., GAGE, ROBERT P., MacKINNON, HECTOR N., and JONES, PETER H.:** Controlled study of cortisone therapy for headache after pneumoencephalography (ab), April, 600
- FLYNN, ROBERT E.** See **KERR, H. DABNEY**
- FÖLDI, M.** See **GERGELY, R.**
- FOGEL, MARIE, and FEJÉR, ROSE:** Hyperostosis generalisata (ab), Jan., 138
- FORAMEN**
- intervertebral. See Spine
- Morgagni's. See Hernia, diaphragmatic
- FORD, A. B.** See **MOIR, T. W.**
- FORD, WILLIAM B., KENT, EDWARD M., NEVILLE, JOHN F., Jr., and FISHER, DON L.:** "Coin" lesions of the lung (ab), Jan., 125
- FOREMAN, JOSEPH.** See **ISARD, HAROLD J.**
- FORREST, A. P. M., PEEBLES BROWN, D. A., MORRIS, SASHA R., and ILLINGWORTH, C. F. W.:** Pituitary radium implant for advanced cancer (ab), March, 462
- FOSSA, POSTERIOR.** See Brain
- FOUSEK, MILDRED D.** See **GREEN, MORRIS**
- FOWLER, FRED D., ALEXANDER, EBEN, Jr., and DAVIS, COURTLAND H., Jr.:** Pinealoma with metastases in the central nervous system. A rationale of treatment (ab), March, 462
- FRACTURES**
- See also under names of bones
- clinical and roentgen aspects of fracture cases (ab), R. Patry and S. Gueukdijian, March, 452
- FRÄNKEL, M.** See **SCHÖRR, S.**
- FRANCHI, B.:** Radiological signs of congenital subluxation of the hip, with description of a new sign (ab), Jan., 140
- FRANCKE, WALTER:** Roentgenologic findings of small intestine in 100 repatriated prisoners of war. Deficiency states and worm infestations (ab), May, 773
- FRANCO, VICTOR H., and QUINA, MARIO G.:** Pneumothorax: a new procedure for determining the mass of the thyroid gland for the radioiodine treatment of hyperthyroidism (ab), June, 912
- FRANK, HOWARD A., REINER, LEOPOLD, and FLEISCHNER, FELIX G.:** Co-occurrence of large leiomyoma of the esophagus and squamous-cell carcinoma of the thymus. Report of a case, with roentgenologic, pathological and clinical discussion (ab), May, 772
- FRANKSSON, C., LINDBLOM, K., and WHITEHOUSE, W.:** Reliability of roentgen signs of varying degrees of malignancy of bladder tumors (ab), Feb., 301
- FRANTZ, CHARLES H.** See **WILTSE, LEON L.**
- FRASER, ELEANOR R.** See **ENGLE, ROBERT B.**
- FREEDLAND, MORRIS E.:** Multiple myeloma. A case diagnosed without x-ray evidence of bone lesions (ab), March, 452
- FREEDMAN LECTURES,** University of Cincinnati, March, 426
- FREEMAN, V.** See **BRETT, G. Z.**
- FREID, J. R.** See **NETSKY, MARTIN G.**
- FREY, JULIUS.** See **BIRKNER, RUDOLPH**
- FRICKE, ROBERT E., and DECKER, DAVID G.:** Intensive divided dose irradiation therapy of carcinoma of the uterine cervix: rationale and late results (ab), Feb., 304
- FRIED, L.:** Evaluation of the cystic duct stump in intravenous cholangiography (ab), May, 775
- FRIEDMAN, H.** See **KING, P.**
- FRIEDMAN, MILTON, and PEARLMAN, ALEXANDER W.:** Irradiation of advanced cancer of the head and neck through a grid. Part I. Study of absorbed dose by observation of skin and mucosal reactions, June, 852
- FRIEDMAN-BAROU, HANNAH.** See **SALINGER, HANS**
- FRIEDMANN, ASA B.:** Diverticula of the appendix. Case report, Jan., 86
- See **BELL, ROBERT L.**
- FRIGYESI, GY.:** Cherubism—familial fibrous dysplasia of the jaws (ab), March, 436
- FRISCHKORN, HUNTER B., Jr.:** Roentgenographic behavior of the ureter (ab), March, 458

- FRITZ-NIGGLI, HEDI:** Professional radiation injuries in medical practice (ab), Jan., 153
- FROST, THOMAS T.** See **SUSSMAN, MARCY L.**
- FROWEIN, R.:** Angiographic findings in cerebral vascular disease and their relationship to clinical syndromes (ab), May, 756
- FULLENLOVE, TOM M., and WILLIAMS, A. JUSTIN:** Comparative roentgen findings in symptomatic and asymptomatic backs, April, 572
- FULLER, DENIS:** Carcinoma of the oesophagus and gastric cardia (ab), June, 908
- FULLER, JOHN B., CHEN, IRENE, LAUGHLIN, JOHN S., and HARVEY, ROGER A.:** Comparison of biological effects of whole-body irradiation with 22.5-Mev x-rays, 18-Mev electrons, and 400-Kev x-rays in the rat (ab), Feb., 315
- See **MOOS, W. S.**
- FURSTE, WESLEY, and AYRES, PERRY R.:** Acute intermittent porphyria with acute abdominal findings and palpable mass (ab), Feb., 302
- FURTH, JACOB, and TULLIS, JOHN L.:** Carcinogenesis of radioactive substances (ab), May, 791
- G**
- GAEBEL, E.:** The negative or faint (weak contrast) cholecystogram and the diagnosis of cholecystitis (ab), Jan., 134
- GAGE, ROBERT P.** See **FLY, ORCENETH, A., Jr.**
- GAINES, L. M., Jr.** See **MANDEL, WILLIAM**
- GALAMBOS, JOHN T., and KIRSNER, JOSEPH B.:** Tubeless gastric analysis in the study of acid secretion following gastric irradiation for peptic ulcer (ab), Feb., 306
- GALE, GODFREY L., and GIFFIN, R. H.:** Pneumoperitoneum in the diagnosis of pelvic disease (ab), Jan., 141
- GALIBERT, P.** See **LAINE, E.**
- GALLBLADDER**
See also **Biliary Tract**
calculi
—biliary tract studies. I. X-ray diffraction analysis of gallstones; correlation with occurrence of microspherulites in bile (ab), Kerrison Juniper, Jr., and William E. Woolf, Jan., 134
—experiences with diagnostic angiography and "peroperative radionuclide" in cholelithiasis (ab), A. Ritter and H. Helmig, March, 450
- diseases**
—acute emphysematous cholecystitis (ab), J. Kenneth Jacobs, March, 449
—acute pneumocholecystitis (ab), Carl J. Heifetz, Jan., 134
—acute pneumocholecystitis; review of literature and report of case (ab), Edward G. LaCour and Lawrence J. O'Neil, April, 610
—negative or faint (weak contrast) cholecystogram and diagnosis of cholecystitis (ab), E. Gaebel, Jan., 134
—volumetric findings in emptying test in non-calculous cholecystopathies (ab), C. Wieser, March, 450
- diverticula**
—cholecystographic visualization of Rokitsansky-Aschoff sinuses; report of case and review of literature (ab), Robert D. Waller and S. M. Roberts, April, 609
- excision.** See **Bile Ducts; Biliary Tract**
- roentgenography.** See also **Biliary Tract**, **roentgenography**; other subheads under **Gallbladder**
—basic combined cholecystangiography (ab), David J. Mitchell, Jan., 136
—cholecystography and cholangiography; review of present methods of examination (ab), Noel H. Aldridge, April, 609
—cholecystography during lactation (ab), Kaj H. Holmdahl, Feb., 295
—cholegraphic signs of acute biliary stasis (ab), Georg Theander, April, 610
—combined intravenous cholecystography and pyelography (with simultaneous administration of Biligrafin and Diodone) (ab), N. H. Aldridge, Jan., 143
—comparative study of newer contrast media (Teridax, Telepaque, and Cholografen) used in cholecystography and cholangiography (ab), Carl P. Wisoff and Benjamin Felson, May, 774
—comparison of rapid intravenously and orally administered contrast mediums for routine gallbladder study (ab), V. Kremens et al, Feb., 294
—delayed visualization of gallbladder due to gastric retention (ab), S. A. Leader, May, 774
—evaluation of oral cholecystography in liver disease (ab), William Mandel et al, Jan., 134
—heterotrophic excretion of intravenously injected contrast media, Julian Arendt and Adam Zgoda, Feb., 238
—intravenous cholecystocholangiography in emergency abdominal diagnosis (ab), Robert S. Sparkman and Paul R. Ellis, March, 450
—new techniques (ab), L. Henry Garland, May, 774
—positional relation of gallbladder to hepatic flexure (ab), Harold G. Jacobson et al, May, 773
—radiographic demonstration of choledochal cyst by oral cholecystography, John E. Moseley, June, 849
—re-evaluation of fat-free preparatory meal in Telepaque cholecystography (ab), Walter M. Whitehouse, May, 775
—visualization of bile ducts in cholangiography (ab), Georg Theander, March, 450

- visualization of renal pelvis in cholegraph (ab), Georg Theander, Feb., 295
- GALLIUM.** See **Radioactivity, radiogallium**
- GAMBACINI, P.:** Radiation combined with surgery in the treatment of rectal neoplasms in various stages (ab), Jan., 145
- GAMBLE, DEAN.** See **MOORE, VINCENT**
- GAMMA RAYS.** See **Dosimeters and Dosimetry; Radioactivity**
- GANEM, EMIL J., WALLWORK, DAVID W., and WEST, GEORGE V.:** Anterior displacement of the descending duodenum as an aid in the diagnosis of retroperitoneal tumor: a roentgenographic sign of possible significance in some cases of enlargement of the right adrenal gland (ab), Jan., 132
- GARCIA, JOHN, KIMELDORF, DONALD J., and HUNT, E. L.:** Conditioned responses to manipulative procedures resulting from exposure to gamma radiation (ab), May, 795
- GARCÍA CASTAÑEDA, MÁXIMO, BALANZARIO, ISAIAS, MACIAS, BENJAMÍN, MARTÍNEZ FABRE, CARLOS, and ZARKIN T., MOISÉS:** Radiological anatomy of the temporal bone (ab), June, 885
- GARDINI, GIOVANNI F., and BETTI, ROBERTO:** The radiologist facing evident and latent thymic hypertrophy (ab), June, 910
- GARDNER, FRANK H.:** A malabsorption syndrome in military personnel in Puerto Rico (ab), 772
- See **RODRIGUEZ, HECTOR F.**
- GARDNER, W. JAMES, TODD, EDWIN M., and PINTO, J. PORTUGAL:** Roentgenographic findings in trigeminal neuralgia (ab), June, 885
- GARLAND, L. HENRY:** New techniques in cholecystography (ab), May, 774
Treatment of cancer of the thyroid gland (ab), April, 618
- GARRITANO, ANTHONY P., WOHL, GEORGE T., KIRBY, CHARLES K., and PIETROLUONGO, ANTHONY L.:** Roentgenographic demonstration of an arteriovenous fistula of renal vessels (ab), March, 444
- GARY, JOHN E.:** Late follow-up study of radiologic changes after mitral valvuloplasty (ab), March, 441
- GASPAR, MAX R.** See **KENDIG, TOM A.**
- GASSTER, MARVIN.** See **HALSTED, JAMES A.**
- GASTRECTOMY.** See **Stomach, surgery**
- GASTRITIS.** See **Stomach**
- GASTROINTESTINAL TRACT**
See also **Colon; Intestines; Stomach**; etc.
—roentgen findings due to untoward effects of hexamethonium, Irving K. Ettman, C. D. Bouchillon and H. H. Halford, May, 673
—teaching aids for instruction in radiologic study of gastrointestinal tract (ab), H. R. Osheroff, April, 610
—timed disintegration capsules; an in vivo roentgenographic study (ab), Theodore M. Feinblatt and Edgar A. Ferguson, Jr., March, 460
- CANCER**
—clinical aspects of treatment of carcinomas with isotopes (ab), Josef Becker and Kurt E. Scheer, June, 913
- GASUL, B. M.** See **DAVIS, CARL, Jr.**
- GAULDEN, E. C.** See **BRISTOW, J. D.**
- GEIGER COUNTER.** See **Counters**
- GEISELSODER, J. L.** See **NIMS, L. F.**
- GENERAL PRACTICE**
—radiation protection for general practitioner (ab), Lauriston S. Taylor, June, 916
- GENERATOR (2-MEV Van de Graaff).** See **Roentgen Therapy**
- GENES.** See **Heredity**
- GENSINI, GOFFREDO.** See **BLOUNT, S. GILBERT, Jr.**
- GERGELY, R., ZSEBÖK, Z., and FÖLDI, M.:** Diagnostic possibilities of lymphangiography (ab), June, 906
- GERRITS, J. C.:** Coin lesions (ab), May, 764
- GERSHBEIN, LEON L.:** X-irradiation and liver regeneration in partially hepatectomized rats (ab), April, 635
- GERSHON-COHEN, J., INGLEBY, HELEN, and MOORE, LOLITA:** Can mass x-ray surveys be used in detection of early cancer of the breast? (ab), May, 771
- See **BUDIN, EARL**
- GERSTNER, HERBERT B.** See **BROOKS, PHILLIPS M.**
- GETZ, S. H.** See **COPE, E.**
- GIBBS, JONATHAN C., Jr.** See **HALLIGAN, EARL J.**
- GIESELMAN, RALPH V., COLLODI, GEORGE A., and PARK-HILL, URIE A.:** Transverse colon in a right inguinal hernia with a confusing distortion of the stomach (ab), Feb., 292
- GIFFIN, R. H.** See **GALE, GODFREY L.**
- GILBERTSON, EVA L., and GOOD, C. ALLEN:** Roentgenographic signs of tumors of the brain (ab), June, 884
- GILMORE, JOHN H.** See **SOTEROPOULOS, C.**
- GIMLETTE, T. M. D.** See **HICKIE, JOHN B.**
- GIRDANY, B., and DANOWSKI, T. S.:** Muscular dystrophy. II. Radiologic findings in relation to severity of disease (ab), Feb., 295
- GLASSMAN, IRVING, SHAPIRO, ROBERT, and ROBINSON, FRANKLIN:** Air embolism during presacral pneumography: a case report (ab), Jan., 143
- GLAZER, NORMAN M.** See **SLADE, HARRY W.**
- GLOBLASTOMA.** See **Brain, tumors**
- GLIOMA.** See **Brain, tumors**
- GLOVER, ROBERT P.** See **JANTON, O. HENRY**

- GLYCINE. See Radioactivity, radioglycine
- GOADE, WILLIAM J., Jr. See CLARKE, B. G.
- GODDARD, WILLIAM B. See RANDALL, JOHN H.
- GODWIN, JOHN T. See CARROLL, ROBERT E.
- GÖBEL, BRUNO. See SCHERER, EBERHARD
- GOETZ, A. A. See SAMPSON, J. J.
- GOIN, LOWELL S.: Science and solitude vs. clinical consultation. The Carman lecture, March, 319
- GOITER. See Thyroid
- GOLD. See Radioactivity, radiogold
- GOLDBERG, GIL M. See SALTZ, NATHAN J.
- GOLDBERG, H. M., and SMITH, VERNON H.: Acute volvulus of the stomach (ab), March, 447
- GOLDBERG HARRY. See DOWNING, DANIEL F.
- GOLDBERG, M. E. See FEINBERG, S. B.
- GOLDBERG, ROBERT F. See HAMWI, GEORGE J.
- GOLDEN, R. See SHUMWAY, B. W.
- See TOCHILIN, E.
- GOLDEN, ROSS: Contribution of radiologic methods of examination to the detection of organic disease of the small intestine (ab), March, 448
- GOLDFEDER, ANNA. See MOLLURA, JOSEPH L.
- GOLDGRABER, MOSHE B.: Response of esophageal cancer to irradiation. A serial cytologic study of two cases (ab), Feb., 302
- GOLDIE, HORACE, and WEST, HAROLD D.: Effect of peritumoral tissue infiltration with radioactive yttrium on growth and spread of malignant cells (ab), May, 790
- GOLDIN, RALPH R., and SILVER, MAURICE L.: Ophthalmic artery aneurysm, May, 727
- GOLTHAMER, CHARLES T.: Duplication of the clavicle ("os subclaviculare"), April, 576
- GÓMEZ, ZALDIVAR, RAFAEL. See FARIÑAS, LAURA
- GOOD, C. ALLEN. See GILBERTSON, EVA L.
- GOTT, VINCENT L., LESTER, RICHARD G., LILLEHEI, C. WALTON, and VARCO, RICHARD L.: Total anomalous pulmonary return. An analysis of thirty cases (ab), Feb., 288
- GOULD, DAVID M. See DAVES, MARVIN L.
- See WINSTEN, JOSEPH
- GRAHAM, EVARTS A. (obit), May, 747
- GRAHAM, JOHN B.: Treatment of choice in cancer of the uterine corpus (ab), April, 620
- GRAHN, DOUGLAS, SACHER, GEORGE A., and WALTON, HOWARD, Jr.: Comparative effectiveness of several x-ray qualities for acute lethality in mice and rabbits (ab), March, 474
- GRANULOMA
- circumscribed pulmonary lesions in periarteritis nodosa and Wegener's granulomatosis (ab), James V. Rogers, Jr., and Albert E. Roberto, May, 765
- granuloma of neck following Thorotrast angiography (ab) Laurence F. Levy, March, 436
- eosinophilic. See Bones, tumors
- GRANULOMATOSIS. See Granuloma
- GRANULOSA-CELL TUMORS. See Ovary, tumors
- GRAVES, F. T.: Anatomy of the intracranial arteries in health and disease (ab), March, 457
- GRAVES' DISEASE. See Thyroid
- GREEN, B., and SOWERBUTTS, J. G.: A comparative study of the value of sodium acetrizate (Diaginosol) 50 per cent and sodium diatrizoate (Hypaque) 45 per cent in intravenous urography (ab), Jan., 142
- GREEN, MORRIS, NYHAN, WILLIAM L., Jr., and FOUSEK, MILDRED D.: Acute hematogenous osteomyelitis (ab), Jan., 138
- GREEN, ROBERT A. See STONE, DANIEL J.
- GREENE, D., and TRANTER, F. W.: Dosage data for 4,000,000 volt x-rays (ab), Feb., 308
- GREENE, RAYMOND. See ABBATT, JOHN D.
- GREENSPAN, R. H., and FEINBERG, S. B.: Salmonella bacteremia: A case with miliary lung lesions and spondylitis, June, 860
- GREGORY, C. See JONES, D. E. A.
- GREITZ, TORGNY: Rapid serial angiography (ab), June, 882
- GRETENER, ADOLPH J.: Lymphosarcoma: clinical picture, therapy, and prognosis. Experiences of the Department of Radiation Therapy of the University of Zürich from 1936 to 1951 (ab), Jan., 147
- GREULICH, RICHARD C.: An autoradiographic study of organically bound carbon-14 in growing epiphyseal cartilage and bone (ab), April, 632
- GRID THERAPY. See Bronchi, cancer; Cancer, radiotherapy; Neck
- GRIECO, R. VINCENT. See BARTONE, NOEL F.
- See HALLIGAN, EARL J.
- GRIMSON, K. S. See MARGOLIS, G.
- GRISHMAN, ARTHUR. See WACHTEL, FRED W.
- GROS, J.: Grooved atrophy of the parietal bone (ab), June, 885
- GROSS, ROBERT E. See SHWACHMAN, HARRY
- GROVES, H. J. See REYNOLDS, D. F.
- GROVES, LAURENCE K., and EFFLER, DONALD B.: Broncholithiasis. A review of twenty-seven cases (ab), Jan., 128
- GROWTH. See Bones, growth
- GRUCCI, T. See CEMBER, H.
- GUARESCHI, BRUNO. See DI SIENO, ANTONIO
- GUBLER, C. J. See BUSH, J. A.
- GUEUKDJIAN, S. See PATRY, R.
- GUILD, WARREN. See LOONEY, W. B.
- GULLMO, ÅKE: A simple instrument for urethrocytography and fistulography in adults and children (ab), April, 616
- GUM, JANE H. See LANIER, RAYMOND R.
- GUNDERSEN, GUNNAR A., and NICE, CHARLES M., Jr.: Nocardiosis. Case report and brief review of the literature, Jan., 31
- GUNNARSON, ERIC: The bile ducts of cholecystectomized patients with and without dyskinesia before and after morphine injection. A preliminary report (ab), Feb., 294
- GUNNING, A. J. See ROSSALL, R. E.
- GUPTA, K. GOPALAKRISHNIAH. See REDDY, D. J.
- GURDJIAN, E. S. See WEBSTER, J. E.
- GUSTAFSON, P. F., MARINELLI, L. D., and HATHAWAY, E. A.: A case of accidental puncture contaminated with ^{Th232}. Studies on elimination and residual body activity, March, 358
- GUTTMANN, RUTH J.: Two million volt irradiation therapy for inoperable carcinoma of the lung (ab), Feb., 303
- GVOZDANOVIC, V.: Changes in the superficial veins in cases of intracranial expanding processes (ab), May, 757
- GYNECOLOGY. See Fallopian Tubes; Pelvis, blood supply; Uterus
- H
- HABEIN, HAROLD C., Jr., MOERSCH, HERMAN J., and KIRKLIN, JOHN W.: Diverticula of the lower part of the esophagus. A clinical study of one hundred forty-nine nonsurgical cases (ab), April, 607
- HACKENTHAL, H., and RUBE, W.: Changes in the endothoracic organs due to positioning of the patient (ab), March, 436
- HAGEE, G. R. See ANTHONY, D. S.
- HAGEN, P. S. See AMATUZZO, D. S.
- HAGGARD, MARY E. See ROWE, CAROLINE W.
- HAHN, P. F., JACKSON, ANDREW H., STAGGERS, FRANK E., JACKSON, MARVIN A., and CAROTHERS, E. L.: Acute radiation death of dogs receiving a single massive dose of intravenous radioactive gold (ab), April, 629
- HAIGH, MARY V., and PATERSON, EDITH: Effects of a single session of whole body irradiation in the Rhesus monkey (ab), Jan., 154
- HAIR
- perifolliculitis capitis abscedens et suffodiens: its successful treatment with x-ray epilation (ab), Francis H. McMullan and Israel Zeligman, May, 787
- HAJDU, N., HARRIS, M. A., and RAMSAY, GORDON S.: Closed loop obstruction of the afferent limb. A late complication of antecolic partial gastrectomy (ab), June, 895
- HALE, BRIAN C.: Hypaque in intravenous pyelography. An analysis of 50 controlled examinations comparing Hypaque with 50 per cent Diodone (ab), Jan., 142
- HALE, WILLIAM M. See WILLIAMS, WILLIAM L.
- HALFORD, H. H. See ETTMAN, IRVING K.
- HALL, CHARLES A., and OLSON, KENNETH B.: Therapy of malignant lymphomas. I. A study of 116 cases. II. A review (ab), Jan., 147
- HALLIGAN, EARL J., and BABER, JULIUS J.: The clinical significance of air and barium in the biliary tract (ab), June, 897
- GIBBS, JONATHAN C., Jr., GRIECO, R. VINCENT, and McKEOWN, JAMES E.: An evaluation of peripheral arteriosclerotic insufficiency utilizing radioactive iodinated human serum albumin (ab), March, 468
- HALNAN, K. E. See HILTON, GWEN
- HALSTED, JAMES A., LEWIS, PETER M., HVOLBOLL, ELIZABETH E., GASSER, MARVIN, and SWENDSEID, MARIAN E.: An evaluation of the fecal recovery method for determining intestinal absorption of cobalt⁶⁰-labeled vitamin B₁₂ (ab), May, 790
- HAMARTOMA. See Tumors, hamartoma
- HAMBY, WALLACE B.: Surgical treatment of intracranial aneurysms. Results in angiographically located lesions (ab), Feb., 278
- HAMILTON, JOSEPH G. See DURBIN, PATRICIA W.
- HAMMAN-RICH SYNDROME. See Lungs, fibrosis
- HAMMER, RAYMOND W. See SAWYER, KENNETH C.
- HAMMOND, CAROLYN W., and MILLER, C. PHILLIP: Incidence of endogenous bacteremia in x-irradiated rabbits (ab), Feb., 315
- HAMWI, GEORGE J., and GOLDBERG, ROBERT F.: Modern treatment of thymotoxicosis (ab), Feb., 311
- HAND
- See also Fingers and Toes
- interdigital sinuses in barber's hand (ab), H. D. W. Powell, Jan., 140
- HANELIN, JOSEPH, and BAKAY, LOUIS: Encephalography of sellar and parasellar tumors, with particular reference to the anteroposterior projection and olfactory sulci (ab), May, 754
- HANKAMP, LAMAR J.: Calcification of the myocardium. Case report, April, 564
- HANNON, DONALD W. See LEVY, LOUIS M.
- HARKINS, HENRY N. See SCHLOSSER, RALPH J.

- HARPER, PAUL V., LATHROP, KATHERINE A., HARRISON, ROBERT W., THURSTON, CONRAD G., KENNEDY, THELMA T. and MULLAN, JOHN F.:** Isotope implant therapy for internally situated tumors (ab), May, 787
- HARRIS, D. C.** See **KAY, R. E.**
- HARRIS, M. A.** See **HAJDU, N.**
- HARRISON, GUNYON H.** See **SINGLETON, EDWARD B.**
- HARRISON, M. C., and MACNAB, IAN P.:** Hidden anvil fracture of the seventh cervical vertebral body (ab), March, 454
- HARRISON, RICHARD H., III, and DOUBLEDAY, LEONARD C.:** Roentgenological appearance of normal adrenal glands (ab), June, 905
- HARRISON, ROBERT W.** See **HARPER, PAUL V.**
- HARROLD, A. J.:** Alkaptonuric arthritis (ab), March, 452
- HART, HIRAM E.** See **SIEGEL, ELSIE P.**
- HARTMANN, H.** See **KEISER, G.**
- HARVEY, ROGER A.** See **FULLER, JOHN B.**
- See **MOOS, W. S.**
- HARVEY, W. PROCTOR.** See **SCHILDER, DONALD P.**
- HASTREITER, ALOIS R.** See **HOFFMAN, HOWARD A.**
- HATCH, T. F.** See **CEMBER, H.**
- HATHAWAY, E. A.** See **FINKEL, ASHER J.**
- See **GUSTAFSON, P. F.**
- HAUGE, TORMOD:** Atrophy within the brain stem area following injection of Thorotrast into the vertebral artery. Report of case (ab), June, 883
- HAVINGA, JAN.** See **KLIGERMAN, MORTON M.**
- HAWLEY, CHAPIN, and FELSON, BENJAMIN:** Roentgen aspects of intrathoracic blastomycosis (ab), Feb., 284
- HAYDEN, GLEN E.:** Carcinoma of the cervix associated with pregnancy (ab), Feb., 304
- HAYES, THOMAS L.** See **HEWITT, JOHN E.**
- HAYNE, ROBERT A., KEMPE, LUDWIG G., and COXE, WILLIAM:** Surgical treatment of arteriovenous malformations of the brain (ab), March, 435
- HAYS, ROBERT A.** See **MEANEY, THOMAS F.**
- HEAD**
- See also Brain; Cranium
- cranial immobilization device for use in roentgen therapy, Bernard Roswit, Cyprian B. Reid and Stanley J. Malaky, March, 419
- immobilization of head during rotational x-ray therapy, Harry L. Berman, April, 579
- irradiation of advanced cancer of head and neck through a grid. I. Study of absorbed dose by observation of skin and mucosal reactions, Milton Friedman and Alexander W. Pearlman, June, 852
- HEADACHE**
- controlled study of cortisone therapy for headache after pneumoencephalography (ab), Oreneth A. Fly, Jr., et al, April, 600
- from subluxations of cervical articulations (ab), Ákos Kovács, June, 887
- HEALY, J. W.:** Calculation of maximum permissible concentrations for long-lived radioisotopes (ab), April, 626
- HEART**
- See also Cardiovascular System; Thrombosis
- in vivo method for determination of cardiac output, Robert E. Mack, Herschel J. Wells and Robert Pollack, Feb., 245
- isotope studies of blood flow and blood cells (studied by radiocardiography) (ab), Edith H. Quimby, April, 624
- abnormalities.** See also Ductus Arteriosus; Heart, displacement
- absence of left pulmonary artery in Fallot's tetralogy (ab), Richard W. Emanuel and J. Norman Pattinson, May, 769
- angiocardiographic mixing defects as indicators of left to right shunts (ab), Melvin M. Figley et al, April, 603
- cardiac septal defects. I. Ventricular septal defect; analysis of 100 cases studied during life. II. Atrial septal defect; analysis of 100 cases studied during life (ab), Danie F. Downing and Harry Goldberg, March, 439
- combined tricuspid and pulmonary atresia with juxtaposition of auricles (ab), A. M. Stewart and A. Wynn-Williams, April, 605
- diagnosis of congenital heart disease in infants by catheterization and selective angiocardiology (ab), Ib Boesen et al, May, 768
- evaluation of the roentgen manifestations of isolated ventricular septal defect, Theodore E. Keats, Van Allen Kreis and Ellen Simpson, Jan., 9
- persistent ostium primum atrial septal defect (ab), S. Gilbert Blount, Jr., et al, Feb., 287
- radiologic aspects of operable heart disease. III. Hazards of retrograde thoracic aortography: survey, Herbert L. Abrams, June, 812
- calcification.** See Heart, infarction
- catheterization.** See Heart, abnormalities
- diseases**
- basal horizontal lines on chest radiographs: significance in heart disease (ab), R. E. Rossall and A. J. Gunning, April, 603
- relation of pectus excavatum to heart disease (ab), Fred W. Wachtel et al, May, 799
- secondary vascular changes in lungs (ab), Marcy L. Sussman and Thomas T. Frost, Feb., 281
- displacement**
- dextroposition of heart simulating congenital dextrocardia (ab), Werner J. Hollendonner and Bernard H. Pastor, Feb., 287
- infarction**
- calcification of myocardium; case, LaMar J. Hankamp, April, 564
- clearance of radioactive iodine from lower extremities of patients with myocardial infarction (ab), Franz K. Bauer et al, May, 788
- portable serial roentgenkymography in acute myocardial infarction (ab), J. J. Sampson, et al, March, 440
- insufficiency**
- radiology of lung in left heart failure (ab), D. S. Short, Feb., 287
- rate**
- blood pressure and heart rate during angiocardiology, abdominal aortography, and arteriography of lower extremities (ab), A. K. Amundsen et al, April, 604
- roentgenography.** See also other subheads under Heart
- angiocardiology observations of intracardiac flow in the normal and in mitral stenosis (ab), Louis A. Soloff et al, Jan., 128
- in vivo visualization of intracardiac structures with gaseous carbon dioxide; cardiovascular-respiratory effects and associated changes in blood chemistry (ab), M. J. Oppenheimer, June, 893
- intracardiac angiography: controlled instantaneous intracardiac release of contrast material in man (ab), Bernard L. Brofman, May, 767
- systolic expansion or aorto-diastolic displacement. Roentgenkymographic study of left atrial movements in mitral cardiopathy (ab), F. Dalith, Jan., 128
- surgery.** See Mitral Valve
- valves.** See Aortic Valve; Mitral Valve; Pulmonary Valve; Tricuspid Valve
- HEAT**
- similarities in killing by heat and by x-radiation in insect *Dahlbomius fuscipennis* (Zett.), William F. Baldwin, May, 796
- HEATH, DONALD.** See **BROWN, JAMES W.**
- HECHTER, H. H.** See **BOND, V. P.**
- HECK, CHARLES V.:** Hoarseness and painful deglutition due to massive cervical exostoses (ab), April, 600
- HEIFETZ, CARL J.:** Acute pneumocholecystitis (ab), Jan., 134
- HEITE, H.-J., and NICOLAI, K. H.:** A method of measuring the tissue-damaging action of x-rays (ab), May, 793
- See **CERTA, H.**
- HELANDER, C. G., and LINDBOM, Å.:** Roentgen examination of the inferior vena cava in retroperitoneal expanding processes (ab), Feb., 288
- HELGASON, SKULI.** See **LEE, JOHN C.**
- HELMICK, MARIE.** See **LOONEY, W. B.**
- HELMIG, H.** See **ITTER, R.**
- HEMANGIOBLASTOMA.** See Tumors, angioma
- HEMANGIOMA.** See Tumors, angioma
- HEMATOMA.** See Brain; Pleura
- HEMOPHOETIC SYSTEM**
- See also Bones, marrow; Spleen
- efficacy of hematopoietic protective procedures in rats x-irradiated with intestine shielded (ab), Marguerite N. Swift et al, March, 474
- radioactive iron studies in routine hematological practice (ab), G. Wetherley-Mein et al, April, 631
- HEMOSIDEROSIS**
- recurrent pulmonary hemorrhage with hemosiderosis: so-called idiopathic pulmonary hemosiderosis (ab), André J. Bruwer et al, May, 766
- HENDERSON, W. J.** See **MOOS, W. S.**
- HENDRICK, JAMES W.:** Treatment of cancer of the nasal cavity and paranasal sinuses (ab), Jan., 143
- HENSCHKE, ULRICH K.:** A technic for permanent implantation of radioisotopes, Feb., 256
- HENSLER, NESTOR M., and CLEVE, EDWARD A.:** Chronic benign residuals of coccidioidomycosis (ab), May, 765
- HENZI, HAROLD:** Pathological anatomy of the changes involving the pulmonary parenchyma after high doses of x-rays (ab), June, 915
- HEPATIC DUCTS.** See Bile Ducts
- HERBEUVAL, R., and DEBRY, G.:** Experimental staphylococcal bullous pneumopathy (ab), May, 767
- HEREDITY**
- See also Familial Conditions
- genetic speculation based upon animal experimentation in relation to actual human experiences, in treatment of female infertility and sterility by x-ray therapy (ab), Ira I. Kaplan, April, 633
- genetically significant radiation dose from diagnostic use of x-rays in England and Wales; preliminary survey (ab), S. B. Osborn and E. E. Smith, May, 793
- indirect induction of lymphomas in irradiated mice. IV. Genetic evidence of origin of tumor cells from thymic grafts (ab), Henry S. Kaplan et al, May, 795
- HERNIA**
- See also Brain, herniation
- diaphragmatic**
- acquired hiatus hernia (ab), Costantino Zaino and Maxwell H. Poppel, March, 451
- compound diaphragmatic hernia; 5 cases (ab), Charles H. Brown et al, Jan., 137
- partial obstruction of inferior vena cava by herniation of liver through foramen of Morgagni; case, David Rosenblum, Arnold Nussbaum and Solomon Schwartz, March, 399

- HERNIA, diaphragmatic—*cont.***
 —radiologic diagnosis of hiatus hernia (ab), Leslie K. Symmore, June, 894
- inguinal**
 —transverse colon in right inguinal hernia with confusing distortion of stomach (ab), Ralph V. Gieselmann et al, Feb., 292
- HERPE, DANIEL.** See **DUHAMEL, JOSEPH**
- HERSON, RONALD E.:** Meconium ileus, April, 568
- HEWER, T. F.:** Histological diagnosis of undifferentiated tumours in bone (ab), Feb., 302
- HEWITT, JOHN E., and HAYES, THOMAS L.:** X-irradiation and lipoprotein metabolism in various species (ab), April, 636
- HEXAMETHONIUM**
 —gastrointestinal roentgen findings due to untoward effects of hexamethonium, Irving K. Ettman, C. D. Bouchillon and H. H. Halford, May, 673
- HICKIE, JOHN B., GIMLETTE, T. M. D., and BACON, A. P. C.:** Anomalous pulmonary venous drainage (ab), May, 769
- HICKS, SAMUEL P., WRIGHT, KENNETH A., and LEIGH, KENNETH E.:** Time-intensity factors in radiation response. I. The acute effects of megavolt electrons (cathode rays) and high- and low-energy x-rays with special reference to the brain (ab), Jan., 154
- HILL, M. J.** See **WETHERLEY-MEIN, G.**
- HILTON, GWEN, POCHIN, E. E., CUNNINGHAM, R. M., and HALMAN, K. E.:** Role of radiiodine in the treatment of carcinoma of the thyroid (ab), April, 627
- See **SMART, JOSEPH**
- HINKEL, C. L., and SANTINI, L. C.:** Polycystic disease of the kidney in infants. Nephrograms following intravenous urography (ab), May, 784
- HINKEL, CHARLES L. (obit),** Feb., 272
- HIP**
 —See also Femur
 —arterial disease as cause of pain in buttock and thigh (ab), George Bonney, June, 893
 —osteoid osteoma of ischium with hip joint complications (ab), F. G. Stuart, April, 613
- dislocation**
 —contradiction of congenital dysplasia-predislocation hypothesis of congenital dislocation of hip through study of normal variation in acetabular angles at successive periods in infancy (ab), John Caffey et al, March, 455
 —method of measuring torsion of femur in congenital dislocation of hip in children (ab), W. Edgren and L. E. Laurent, March, 456
 —radiological signs of congenital subluxation, with description of new sign (ab), B. Franchi, Jan., 140
- HIRSCH, BARBARA B., BROWN, MARY B., NAGAREDA, C. SUSAN, and KAPLAN, HENRY S.:** Comparative activity of isologous vs. homologous or heterologous mouse marrow in promoting regeneration of the irradiated mouse thymus (ab), May, 795
- See **CARNES, WILLIAM H.**
 —See **KAPLAN, HENRY S.**
- HIRSCHSPRUNG'S DISEASE.** See **Colon, dilatation**
- HISTIOCYTOSIS.** See **Reticuloendothelial System**
- HISTOPLASMIN and HISTOPLASMOSIS**
 —acute fulminating histoplasmosis (ab), George E. Fissel, June, 890
 —disseminated pulmonary calcification: its association with positive reaction to histoplasmin antigen (ab), Mark H. Jorres and Boris Bushnell, April, 601
- HOARSENESS**
 —and painful deglutition due to massive cervical exostoses (ab), Charles V. Heck, April, 600
- HOBBS, ARTHUR A., Jr.** See **BECK, ROBERT E.**
- HOCHBERG, LEW A., and CRASNOPOL, PHILIP:** Primary sarcoma of the bronchus and lung (ab), June, 889
- HODGE, K. E.:** Gravitational placentography, May, 637
- HODGES, FRED J.:** Growing importance of cardiovascular radiology (ab), May, 767
 Position of radiology in cardiovascular diagnosis (ab), March, 439
- HODGKIN'S DISEASE**
 —differentiated histologic findings of lymphogranulomatosis as basis of therapeutic success (ab), Hermann Trübsenstein, March, 465
- HODSON, C. J.:** Localization of pulmonary collapse-consolidation (ab), May, 763
- HOECKER, FRANK E., and WATKINS, IVAN:** Radiation polymerization of liquids, Feb., 257
- HÖFER, RUDOLPH.** See **FELLINGER, KARL**
- HÖFFKEN, W.:** Aspergilloma of the lung (ab), Feb., 285
- HOFFMAN, HOWARD A., KOCZERA, STANLEY J., PORTNOY, NELSON L., SIMAS, WILSON, and HASTREITER, ALOIS R.:** Urologic examination with the new radiopaque mediums diatrizoate, acetrizate, and diatrizoate. A clinical comparison (ab), June, 904
- HOFFMAN, MARILYN.** See **NETSKY, MARTIN G.**
- HOLLENDORNER, WERNER J., and PASTOR, BERNARD H.:** Dextroposition of the heart simulating congenital dextrocardia (ab), Feb., 287
- HOLLINGSWORTH, JOHN C.** See **SNOW, WILLIAM**
- HOLM, OLOV FR.:** Occurrence of free gas in the fetus in cases of intra-uterine death (ab), Feb., 299
- HOLMDAHL, KAJ H.:** Cholecystography during lactation (ab), Feb., 295
- HOLMES, FRANCIS H.** See **SILVIS, RICHARD S.**
- HOLSTI, LARS R.:** Osteochondritis ischiopubica (ab), Jan., 140
- HOLT, J. GARRETT:** A nomographic wheel for three dimensional localization of radio sources and calculation of dose rate (ab), Jan., 150
- HOLTER, I.** See **AMUNDSEN, P.**
- HOPE, JOHN W.** See **NAGLE, W. WILLIAM**
- HORNBUCKLE, LLOYD A.** See **CRAWFORD, EDWARD J., Jr.**
- HORWITZ, NORMAN H.:** Positive contrast ventriculography—a critical evaluation (ab), May, 754
 —and **DUNSMORE, REMBRANDT H.:** Some factors influencing the nonvisualization of the internal carotid artery by angiography (ab), Jan., 122
- HOUGH, GARY.** See **CAFFEY, JOHN**
- HOUSER, JOSEPH M.** See **JONSSON, SIGMUNDUR M.**
- HOWARD, WILLIAM H. R.** See **CLATWORTHY, H. WILLIAM, Jr.**
- HOYT, LYMAN H.** See **MACDONALD, GEORGE E.**
- HSIEH, C. L.:** The stray radiation levels of a 45 MeV travelling wave linear electron accelerator (ab), Feb., 308
- HUANG, KEE-CHANG, and BONDURANT, JAMES H.:** Effect of total body x-irradiation on plasma volume, red cell volume, blood volume and thiocyanate space in normal and splenectomized rats (ab), April, 635
- HUDSON, FRANK.** See **CRAMER, FRITZ**
- HUDSON, GRANVILLE W.:** Venography in superior vena caval obstruction, April, 499
 —See **CONIGLIO, JOHN G.**
- HUFFORD, CLARENCE E.:** Introduction of the Carman lecturer, March, 317
- HUFNAGEL, CHARLES A.** See **SCHILDER, DONALD P.**
- HUGGINS, R. A.** See **SMITH, E. L.**
- HUGHES, H. A., and MILLER, R. M.:** Plasma activity levels in radioiodine tests of thyroid function (ab), Jan., 150
 —See **MURISON, C. A.**
- HUGHES, W. L.** See **ROBERTSON, J. S.**
- HUGHES, WILLIAM F.** See **SILVIS, RICHARD S.**
- HUMERUS**
 fractures
 —uptake of radiolabeled sulfur in fractured humerus in rat (ab), J. C. Osborne and K. Kowalewski, May, 790
- HUMMON, IRVIN F., Jr.** See **LUTTERBECK, EUGENE F.**
- HUNT, E. L.** See **GARCIA, JOHN**
- HUNTER, CURWOOD R.:** Indications and technique of cerebral angiography (ab), Jan., 122
- HUNTER, T.:** Solitary eosinophilic granuloma of bone (ab), March, 452
- HURST, G. S.** See **UPTON, A. C.**
- HUSTON, JOHN H.** See **ROWE, GEORGE G.**
- HUSTON, WILLIAM A.** See **SCHULTZ, E. C.**
- HUTT, M. R. S.** See **WETHERLEY-MEIN, G.**
- HVOLBOLL, ELIZABETH E.** See **HALSTED, JAMES A.**
- HWA, EUGENE C.** See **CORPE, RAYMOND F.**
- HYALINE MEMBRANE.** See **Lungs, pathology**
- HYDATID DISEASE.** See **Echinococcosis**
- HYDROCEPHALUS**
 —vertebral angiography in diagnosis of hydrocephalus and differentiation between stenosis of aqueduct and cerebellar tumor (ab), F. Olov Löfgren, May, 757
 —vertebral angiography in supratentorial expansive processes (ab), F. Columella and I. Papo, May, 758
- HYDROCORTISONE.** See **Adrenocortical Preparations**
- HYDRONEPHROSIS**
 —diagnosis of intermittent hydronephrosis: importance of pyelography during episodes of pain (ab), Reed M. Nesbit, March, 457
 —renal angiography in experimental hydronephrosis (ab), Hans Idhohrn, Feb., 299
- HYPAQUE.** See **Eyes, Prelogy**
- HYPEROSTOSIS GENERALISATA.** See **Bones, pathology**
- HYPEROSTOSIS, INFANTILE CORTICAL.** See **Bones, pathology**
- HYPOPHARYNX.** See **Pharynx**
- HYSTEROGRAPHY.** See **Uterus, hemorrhage**

I

- IANNACONE, G., and BARILLA, M.:** Cyst-like structures in the proximal end of the ulna: anatomic and roentgenological appearance and interpretation (ab), March, 455
- IDBOHRN, HANS:** Renal angiography in experimental hydronephrosis (ab), Feb., 299
- ILEUM.** See **Intestines**
- ILEUS.** See **Intestines, obstruction**
- ILLINGWORTH, C. F. W.** See **FORREST, A. P. M.**
- IMAGE INTENSIFIER.** See **Roentgen Rays, fluoroscopy**
- INDUSTRY AND OCCUPATIONS**
 See also **Caisson Disease; Dentistry; Mines and Miners; Pneumoconiosis, etc.**
 —comparative roentgen findings in symptomatic and asymptomatic backs, Tom M. Fullenlove and A. Justin Williams, April, 572
 —impact of atomic energy industry on community health: panel discussion (ab), May, 793
 —interdigital sinuses in barber's hand (ab), H. D. W. Powell, Jan., 140
 —pulmonary changes in welders: 3 cases (ab), Robert Charr, April, 602

INDUSTRY AND OCCUPATIONS—cont.

- study of effects on lung of industrial exposure to zirconium dusts (ab), C. E. Reed, May, 764
- use of electron beams in industrial processes, E. Dale Trout, May, 708

INDYK, J. S. See RUNDLE, F. F.**INFANTS, NEWBORN**

- See also Infants, Premature; Meconium
- atresia of vagina in infancy (ab), Robert H. Whittlesey et al, June, 902
- congenital goiter, W. William Nagle, John W. Hope and Alfred M. Bongiovanni, April, 526
- congenital intrinsic duodenal obstruction; 32 cases (ab), Thomas C. Moore, June, 895
- congenital tracheoesophageal fistula without atresia of esophagus (ab), Richard Koch and John M. Clark, April, 606
- effect of antepartum diagnostic roentgenography on white blood cell count, Irwin H. Kaiser and James F. Marvin, Feb., 249
- hyaline membrane disease: preclinical roentgen diagnosis. Planned study, S. B. Feinberg and M. E. Goldberg, Feb., 185
- Kartagener's syndrome in newborn infant (ab), Samuel J. Nichamin, May, 766
- mongolism (mongoloid deficiency) during early infancy—some newly recognized diagnostic changes in pelvic bones (ab), John Caffey and Steven Ross, March, 456
- note on congenital laryngeal stridor (ab), T. G. Wilson, April, 601
- roentgenographic findings in respiratory problems of infants (ab), S. B. Feinberg, March, 439
- spontaneous pneumoperitoneum in newborn; case (ab), Arnold Porter, Feb., 293

INFANTS, PREMATURE

- study of uptake of iodine (I-131) by thyroid of premature infants (ab), Edgar E. Martner et al, Feb., 309

INFARCTION. See Bones; Heart; Lungs

- INGLEBY, HELEN, AND MOORE, LOLITA: Periodic roentgenographic studies of a growing human mammary cancer (ab), June, 894

—See GERSHON-COHEN, J.**INSULIN**

- disulfide reduction and release of iodide 131 following irradiation of ^{131}I labeled proteins, Rosalyn S. Yalow and Solomon A. Herson, Jan., 100

INTERLINGUA SUMMARIES (ed), Jan., 106**INTERNATIONAL CANCER CONFERENCE (SEVENTH), April, 586****INTERNATIONAL CONVENTION OF X-RAY TECHNICIANS (SECOND), March, 426****INTESTINES****See also Colon; Gastrointestinal Tract**

- contribution of radiologic methods of examination to detection of organic disease of small intestine (ab), Ross Golden, March, 448
- malabsorption syndrome in military personnel in Puerto Rico (ab), Frank H. Gardner, May, 772
- radiology of inflamed small intestine: functional and organic signs of inflammatory disease (ab), E. Chérigé, Jan., 133
- roentgenological findings of small intestine in 100 repatriated prisoners of war. Deficiency states and worm infestations (ab), Walter Francke, May, 773

effects of radiation

- biosynthesis of fatty acids in liver and intestine of intact normal, fasted and x-irradiated rats (ab), John G. Coniglio et al, April, 635
- corticotropin (ACTH) gel in treatment of irradiation enterocolitis; 2 cases (ab), George E. MacDonald and Lyman H. Hoyt, June, 917
- efficacy of hematopoietic protective procedures in rats x-irradiated with intestine shielded (ab), Marguerite N. Swift et al, March, 474
- evaluation of fecal recovery method for determining intestinal absorption of cobalt 60 -labeled vitamin B $_{12}$ (ab), James A. Halsted et al, May, 790
- importance of intestinal flora in radiation treatment of gynecological carcinomata (ab), J. Breitner and W. Roth, April, 621
- modification of acute intestinal radiation syndrome through shielding (ab), Marguerite N. Swift and S. Tom Taketa, April, 634
- nature of intestinal radiation death (ab), Henry Quastler, March, 474
- prevention of intestinal radiation death by removal of irradiated intestine (ab), James W. Osborne, April, 634
- radiation injury to small bowel with special consideration of surgical complications (ab), H. Harvey Peterson and Edwin G. Clausen, May, 791
- some effects of ionizing radiation on physiology of gastrointestinal tract: review (ab), Robert A. Conard, June 916

obstruction. See also Intussusception

- closed loop obstruction of afferent limb; late complication of antecolic partial gastrectomy (ab), N. Hajdu et al, June, 895
- from radiological point of view (ab), Everett L. Pirkey and Dale Udem, April, 609
- meconium ileus, Ronald E. Herson, April, 568

- meconium ileus; clinical study of 20 surviving patients (ab), Harry Shwachman et al, Jan., 132

- meconium plug syndrome (ab), H. William Clatworthy, Jr., et al, March, 448

- studies in recognition of strangulating obstructions with special reference to value of pneumoperitoneography (ab), John F. Perry, Jr., et al, April, 609

roentgenography. See also Cecum; other subheads under Intestines

- improved technic for double-contrast examination of colon by use of compressed carbon dioxide, George Levene and S. A. Kaufman, Jan., 83
- self-retaining barium-enema tip: improvement, William Snow and John C. Hollingsworth, March, 418

tumors

- hemangioma of small intestine, Seymour Ochsner and Rawley M. Penick, Jr., June, 845
- malignant argentaffinoma associated with cardiovascular abnormalities (ab), W. R. Eyler et al, Jan., 129
- multiple lipomas of ileum (ab), John W. Findley, Jr., and William H. Thompson, Jan., 133

ulcers

- ulcerative jejunitis in polyarteritis, Alice Ettinger and R. heri Perez-Tamayo, May, 669

volvulus

- of cecum and sigmoid colon; analysis of 9 cases (ab), Thomas G. Nelson and Warner F. Bowers, Feb., 292

INTRIERE, ANTHONY D., and BROWN, CHARLES H.: Primary amyloidosis. Report of a case of gastric involvement only (ab), March, 447**INTRINSIC FACTOR**

- studies in urinary excretion of vitamin B $_{12}$ Co 60 in pernicious anemia for determining effective dosage of intrinsic factor concentrates (ab), William R. Best et al, March, 471

INTUSSUSCEPTION

- as cause of "disappearing" carcinoma of rectum (sigmoid) (ab), Harvey J. Dworkin, Feb., 293
- in adults (ab), David L. Dean et al, June, 895
- in children and adults; collective review (ab), Marshall J. Orloff, Feb., 293

IODINE AND IODINE COMPOUNDS**See also Biliary Tract, roentgenography; Pycnography; etc.**

- danger of aortography in localization of pheochromocytoma (ab), Nathan J. Saltz et al, May, 785
- effect of intravenous Benadryl in allaying allergic manifestations of 70 per cent Urokon (ab), Jack Lapides and Robert E. Boyd, April, 617
- iodide "mumps" after intravenous urography (ab), Ralph M. Sussman and Jay Miller, June, 905
- major reactions to intravenous urographic media (Urokon) (ab), Charles H. Nicolai, June, 904
- monochromatic roentgen rays in (iodine-containing) contrast media roentgenography (ab), Michel Ter-Pogossian, Feb., 301
- paraplegia secondary to abdominal aortography (with Urokon) (ab), Joseph G. McCormack, April, 605
- physiological effect of contrast media (Neo-Iopax, Diodrast, and Urokon) used for angiocardiology (ab), George G. Rowe et al, April, 604
- reactions due to intravenous Urokon (ab) Vernon H. Youngblood et al, April, 617
- vascular responses to intra-arterial Diodrast and Urokon during arteriography (ab), Robert S. Shaw, March, 443

radioactive. See Radioactivity, radioiodine; Thyroid**IODIPAMIDE METHYLGLUCAMINE. See Biliary Tract, roentgenography****IONIZATION CHAMBERS**

- flux of secondary ionizing particles in uniformly irradiated homogeneous medium of varying density: application to walled ionization chambers (ab), G. Failla, Feb., 309
- periodic control of function and constancy of ionization chamber dose meters (ab), R. Thoraeus, April, 623
- tissue equivalent ionization chambers (ab), Harald H. Rossi and G. Failla, March, 465

IRIDIUM. See Radioactivity, radioiridium**IRON AND IRON COMPOUNDS****See also Radioactivity, radioiron; Siderosis**

- advances toward a stable sensitive iron dosimeter, Gail D. Adams and William R. Balkwell, Jan., 101

IRVINE, R. E.: Outcome of uncomplicated syphilitic aortitis (ab), Feb., 288**ISAAC, FRANK, BREM, THOMAS H., TEMKIN, EUGENE, and MOVIUS, HERBERT J.: Congenital malformation of the renal artery, a cause of hypertension, May, 679****—SCHOEN, IRWIN, and WALKER, PHYLLIS: An unusual case of Lindau's disease. Cystic disease of the kidneys and pancreas with renal and cerebellar tumors (ab), March, 460****ISARD, HAROLD J., BERGELSON, VICTOR D., and FOREMAN, JOSEPH: Mediastinal pneumography (ab), Feb., 285****ISCHMUS**

- osteochondritis ischiopubica (ab), Lars R. Holsti, Jan., 140
- osteoid osteoma of ischium with hip joint complications (ab), F. G. Stuart, April, 613

ISHERWOOD, JOHN A., SIMPSON, JOHN W., and SAENGER, EUGENE L.: Carcinoma of the uterine cervix. Four years of cooperation of gynecologist and radiotherapist (ab), Feb., 304

ISOTOPES. See Radioactivity

ISRAEL, HAROLD L. See STEIN, GEORGE N.

J

JACKNOW, ALBERT S. See O'CONNOR, SYLVESTER J.

JACKSON, ANDREW H. See HAHN, P. F.

JACKSON, MARVIN A. See HAHN, P. F.

JACKSON, ROBERT C., McDONALD, JOHN R., and CLAGETT, O. THERON: Massive cystic pulmonary hamartoma. Report of two cases (ab), Feb., 282

JACOBS, J. KENNETH: Acute emphysematous cholecystitis (ab), March, 449

JACOBS, LEWIS G. See PONTIUS, JOHN R.

JACOBSEN, H. H.: Suboccipital gas myelography in diagnosis of herniated disc in the cervical segment (ab), May, 783

JACOBSON, A. See MEURK, M. L.

JACOBSON, GEORGE, SCHWARTZ, LEONARD H., and SUSSMAN, MARCY L.: Radiographic estimation of pulmonary artery pressure in mitral valvular disease, Jan., 15

—See ENGLE, ROBERT B.

—and ZUCHERMAN, SIDNEY D.: Roentgenographically demonstrable splenic deposits in sickle cell anemia (ab), June, 905

JACOBSON, HAROLD G., SHAPIRO, JEROME H., STERN, WILHELM, and POPPEL, MAXWELL H.: Positional relation of gallbladder to hepatic flexure (ab), May, 773

—See POPPEL, MAXWELL H.

JAFKE, HENRY L.: Juxtaarticular chondroma (ab), April, 610

JAIMET, C. H., and THODE, H. G.: Further clinical studies of thyroid and salivary gland function with radioiodine (ab), April, 627

JAMES, J. A.: Renal tubular disease with nephrocalcinosis. Report of two unusual cases (ab), April, 615

JAMES, J. I. P.: Paralytic scoliosis (ab), June, 899

JANKER, R.: Dosages in diagnostic roentgenology (ab), March, 473

—Television in diagnostic roentgenology (ab), Feb., 301

JANSEN, G. THOMAS, and CURTIS, ARTHUR C.: X-ray exposure in dermatology personnel (ab), May, 792

JANTON, O. HENRY, DAVILA, JULIO C., and GLOVER, ROBERT P.: Status of fifty patients four and a half to seven years after mitral commissurotomy (ab), June, 891

JAVERT, CARL T., and DOUGLAS, R. GORDON: Treatment of endometrial adenocarcinoma. A study of 381 cases at the New York Hospital. Preliminary report (ab), Jan., 145

JAWS

—cherubism—familial fibrous dysplasia of jaws (ab), Gy. Frigyesi, March, 436

JEANJEAN, Y. See TURLAP, J.

JECH, ČESTMÍR: Retention of radon decay products in human lungs (ab), May, 793

JEFFERSON, ANTHONY, and SHELDON, PHILIP: Transient herniation of the brain as revealed by the displacement of arteries (ab), May, 760

JEJUNUM. See Intestines

JENNINGS, W. ALAN: Percentage depth dose in moving-field therapy, May, 698

—and McCREA, ALICE L.: Dose distribution in conical rotation therapy at 2 MeV, Jan., 104

Dose distribution in conical rotation therapy with a 2-MEV generator, May, 689

JENSEN, VIDAR, and WOLFF, AAGE: Congenital intralobar sequestration with anomalous artery from the aorta (ab), March, 437

JEROME, EDWARD A. See CHAPMAN, WILLIAM H.

JIROUT, JAN: Changes in the size of the subarachnoid spaces after the insufflation of air (ab), May, 753

—Studies in the dynamics of the spine (ab), May, 780

JOHNS, H. E., MORRISON, M. T., and WHITMORE, G. F.: Dosage calculations for rotation therapy, with special reference to cobalt 60 (ab), April, 631

—See BRUCE, W. R.

—See REID, W. B.

—See SKARSGARD, L. D.

JOHNSON, PHILIP C. See BEIERWALTES, WILLIAM H.

JOHNSTON, DAVID O. See WISE, ROBERT E.

JOHNSTON, PAUL W., and WEINBERG, JOSEPH A.: Significance of pulmonary coin lesions (ab), May, 764

JOHNSTONE, HERBERT G. See STEINBACH, HOWARD L.

JOINTS

—See also under names of joints, as Ankle; Hip; Knee

—bone, joint and soft-tissue changes following paraplegia, Thomas Lodge, May, 780

—joint and bone disease due to mycotic infection (ab), Elam C. Toone, Jr., and John Kelly, Jan., 138

JÓNA, I. See RÓTH, M.

JONES, D. E. A., GREGORY, C., and BIRCHALL, I.: Dosage distribution in rotational cobalt 60 therapy (ab), Feb., 308

JONES, JAMES C. See WHITTLESEY, ROBERT H.

JONES, MALCOLM D., STEINBACH, HOWARD L., and RAPHAEL, ROBERT L.: Sodium amidotrizoate (Hypaque) and sodium acetrizoate (Urokon). Comparison of efficacy in intravenous urography (ab), June, 904

JONES, PETER H. See FLY, ORCENETH A., Jr.

JONSSON, SIGMUNDUR M., and HOUSER, JOSEPH M.: Scleroderma (progressive systemic sclerosis) associated with cancer of the lung. Brief review and report of case (ab), June, 889

JORDAN, DONN L. See VOGEL, HOWARD H., Jr.

JORESS, MARK H., and BUSHUEFF, BORIS: Disseminated pulmonary calcification: its association with a positive reaction to histoplasmin antigen (ab), April, 691

JUNIPER, KERRISON, Jr., and WOOLF, WILLIAM E.: Biliary tract studies. I. X-ray diffraction analysis of gallstones; correlation with occurrence of microspherulites in bile (ab), Jan., 134

JUSTER, M. See FISCHGOLD, H.

K

KAHR, ERNST: Grid therapy of bronchial carcinoma (ab), May, 786

KAISER, IRWIN H., and MARVIN, JAMES F.: Effect of antepartum diagnostic roentgenography on the white blood cell count of the newborn infant, Feb., 249

KALLMAN, ROBERT F., and KOHN, HENRY I.: The reaction of the mouse spleen to x-rays measured by changes in organ weight (ab), Feb., 314

KAMIETH, H.: Diagnosis and differential diagnosis of chronic supracardial changes of the lower esophagus (ab), April, 606

KANE, J. J. See ASHMORE, J. D.

KAPLAN, ERVIN. See FIELDS, THEODORE

KAPLAN, GUSTAVE, ADLER, HOWARD, and ROSWIT, BERNARD: Carcinoma of the scrotum (ab), Feb., 306

KAPLAN, HENRY S., BROWN, MARY B., HIRSCH, BARBARA B., and CARNES, WILLIAM H.: Indirect induction of lymphomas in irradiated mice. II. Factor of irradiation of the host (ab), May, 794

—CARNES, WILLIAM H., BROWN, MARY B., and HIRSCH, BARBARA B.: Indirect induction of lymphomas in irradiated mice. I. Tumor incidence and morphology in mice bearing nonirradiated thymic grafts (ab), May, 794

—See CARNES, WILLIAM H.

—HIRSCH, BARBARA B., and BROWN, MARY B.: Indirect induction of lymphomas in irradiated mice. IV. Genetic evidence of the origin of the tumor cells from the thymic grafts (ab), May, 795

—See HIRSCH, BARBARA B.

KAPLAN, IRA I.: Genetic speculation based upon animal experimentation in relation to actual human experiences, in the treatment of female infertility and sterility by x-ray therapy (ab), April, 633

KAPOSI'S SARCOMA. See Sarcoma, Kaposi's

KARK, ROBERT M. See SCHOENBERGER, JAMES A.

KARTAGENER'S TRIAD. See Bronchiectasis

KASSENBAAR, A. A. H. See STANBURY, JOHN B.

KATZ, S. See REMOLAR, JORGE

KATZ, SOL. See DAVIS, EDGAR W.

KAUFMAN, JOSEPH J., and RUSSELL, MURRAY: Cystourethrography. Clinical experience with the newer contrast media (ab), March, 458

KAUFMAN, S. A. See LEVENE, GEORGE

KAWASHIMA, E. See SOTEROPOULOS, C.

KAY, R. E., HARRIS, D. C., and ENTENMAN, C.: Urinary excretion and plasma levels of free ninhydrin reactive compounds in x-irradiated rats (ab), May, 796

KEATING, F. RAYMOND, Jr. See McCONAHEY, WILLIAM M.

KEATS, THEODORE E.: Dysplasia epiphysealis hemimelica (tarsal-epiphyseal aklasia), April, 558

—KREIS, Van ALLEN, and SIMPSON, ELLEN: An evaluation of the roentgen manifestations of isolated ventricular septal defect, Jan., 9

KEETTEL, WILLIAM C., and ELKINS, H. B.: Experience with radioactive colloidal gold in the treatment of ovarian carcinoma (ab), Jan., 151

—See ELKINS, H. B.

KEISER, G., and HARTMANN, H.: Atypical reticulum cell sarcoma of the skeletal system (ab), June, 898

KELLY, EUGENE W. See SOLOFF, LOUIS A.

KELLY, JOHN. See TOONE, ELAM C., Jr.

KEMP, F. H. See ARDRAN, G. M.

KEMPE, LUDWIG G. See HAYNE, ROBERT A.

KENDIG, TOM A., GASPARD, MAX R., SECREST, PETTUS G., and SHACKFORD, B. C.: Calcification in gastric carcinoma. Case report, Jan., 80

KENNEDY, ROBERT J. See MILLER, WILLIAM

KENNEDY, ROGER L. J. See BRUWER, ANDRÉ J.

KENNEDY, THELMA T. See HARPER, PAUL V.

KENNEY, LEO J., and EYLER, WILLIAM R.: Preoperative diagnosis of sequestration of the lung by aortography (ab), Feb., 281

KENT, EDWARD M. See FORD, WILLIAM B.

- KENT, H. P.** See **BARCLAY, T. H. CRAWFORD**
- KERNWEIN, GRAHAM A., SNEED, WILLIAM R., JR., ROSEBERG, BERTIL, and ZEIER, FRANCIS G.:** Arthrography of the shoulder as a diagnostic aid in tendon injuries (ab), Feb., 297
- KERR, H. DABNEY, and FLYNN, ROBERT E.:** Role of irradiation in the treatment of Wilms' tumor in children (ab), March, 465
- KESKEY, G. RICHARD, and LETSCH, WILLIAM R.:** Retrobulbar air injection with planigraphy (ab), June, 886
- KIDNEYS**
See also Hydronephrosis; Pyelography; Uremia
—artificial kidney and ion exchange resins as possible methods of removing radioelements from the body, W. B. Looney, C. J. Maletskos, Marie Helmick, John Reardon, Jonathan Cohen and Warren Guild, Feb., 255
—clinical study of new renal function test: radioactive Diadrast (tagged with ^{131}I) renogram (ab), Chester C. Winter, June, 903
blood supply. See Aneurysm, renal; Arteries, renal; Fistula, arteriovenous; Hydronephrosis
calcification
—nephrocalcinosis in patient with duodenal ulcer disease: case associated with parathyroid adenoma (ab), Robert E. Mitchell, Jr. et al, April, 615
—renal tubular disease with nephrocalcinosis; 2 unusual cases (ab), J. A. James, April, 615
—"spongy" kidney and nephrocalcinosis (ab), G. Balestra and B. Delpino, June, 903
cancer
—arteriovenous fistula of renal vessels (caused by adenocarcinoma); case (ab), Jon R. Myhre, June, 903
—differential diagnosis between cancer and solitary serous cyst (ab), B. G. Clarke et al, April, 615
—vertebral metastasis in renal carcinoma: anatomic correlation (ab), George T. Wohl, March, 454
cysts. See also Kidneys, tumors
—differential diagnosis between cancer and solitary serous cyst (ab), B. G. Clarke et al, April, 615
—polycystic disease in infants; nephrograms following intravenous urography (ab), C. L. Hinkel and L. C. Santini, May, 784
—radiologic picture of medullary sponge kidney: review of literature and presentation of 2 cases (ab), Antonio Di Sieno and Bruno Guareschi, Jan., 141
—"spongy" kidney and nephrocalcinosis (ab), G. Balestra and B. Delpino, June, 903
—ureteritis cystica and pyelitis cystica; review of cases and roentgenologic criteria, Bernard S. Loitman and Harold Chiat, March, 345
diseases
—renal tubular disease with nephrocalcinosis; 2 unusual cases (ab), J. A. James, April, 615
fistula. See Fistula
insufficiency
—acute renal failure following translumbar aortography (using Urokon Sodium) (ab), Owen C. Berg, May, 784
pelvis
—obstructed ureteropelvic junction, Robert Lich, Jr., March, 337
—visualization of renal pelvis in cholegraphy (ab), George Theander, Feb., 295
roentgenography. See also Pyelography; other subheads under Kidneys
—serious complications associated with newer diagnostic methods in urology (retroperitoneal pneumography and aortography) (ab), William Baurys, March, 459
tumors
—radiotherapy in new growths (ab), E. W. Riches, May, 786
—roentgen diagnosis of neoplasms (ab), J. H. Woodruff et al, Feb., 300
—role of irradiation in treatment of Wilms' tumor in children (ab), H. Dabney Kerr and Robert E. Flynn, March, 465
—treatment of Wilms' tumor (ab), Elmer Ng and Bertram V. A. Low-Beer, April, 621
—unusual case of Lindau's disease: cystic disease of kidneys and pancreas with renal and cerebellar tumors (hemangioblastoma) (ab), Frank Isaac et al, March, 460
- KIERLAND, ROBERT R.** See **BRUWER, ANDRÉ J.**
- KIMELDORF, DONALD J.** See **GARCIA, JOHN**
- KING, DONALD P.** See **STORAASLI, JOHN P.**
- KING, J. CASH:** Trauma to the abdominal and retroperitoneal viscera as it concerns the radiologist (ab), April, 617
- KING, P. LOCKHART, L. B., JR., BAUS, R. A., PATTERSON, R. L., JR., FRIEDMAN, H., and BLIFFORD, I. H., JR.** Rad. RnE and Po in the atmosphere (ab), April, 636
- KING, PHILIP S.** See **LYLE, F. M.**
- KINNORY, DAVID S.** See **FIELDS, THEODORE**
- KIRBY, CHARLES K.** See **GARRITANO, ANTHONY P.**
- KIRKLIN, BYRL RAYMOND** (obit), June, 876
- KIRKLIN, JOHN W.** See **HABEIN, HAROLD C., JR.**
- KIRKPATRICK, ROB H., and RILEY, CONRAD M.:** Roentgenographic findings in familial dysautonomia, May, 654
- KIRSH, ISRAEL E.** See **MANN, LAWRENCE S.**
- KIRSNER, JOSEPH B.** See **GALAMBOS, JOHN T.**
- KLASSEN, KARL P.** See **CRAWFORD, PATRICK**
- KLEIN, M. R.** See **LEFÈBVRE, J.**
- KLIGERMAN, MORTON M., VREELAND, HOWARD W., and HAVINGA, JAN:** A graphical method for the localization of radium sources for dosage calculation (ab), Jan., 149
- KNEE**
—tomographic studies on normal and injured knee (ab), Stig Fagerberg, Feb., 298
- KOCH, H. W.** See **ZENDLE, B.**
- KOCH, RICHARD, and CLARK, JOHN M.:** Congenital tracheoesophageal fistula without atresia of the esophagus (ab), April, 606
- KOCZERA, STANLEY J.** See **HOFFMAN, HOWARD A.**
- KOHLER, G. D.** See **TOCHILIN, E.**
- KOHN, HENRY I.:** On the direct and indirect effects of x-rays on the testis of the rat (ab), Feb., 314
—See **KALLMAN, ROBERT F.**
- KOLB, WALTER:** The scintillation spectrometer, a measuring instrument in radiological practice (ab), June, 911
- KONAR, N. R., CHAUDHURY, D. C. ROY, and CHAUDHURY, R. ROY:** Effects of artificial gaseous distension of stomach and its role in making the liver radiologically visible (ab), Feb., 292
- KONECCI, EUGENE B., TAYLOR, WILLIAM F., and WILKS, SYRREL S.:** Protective action of carbon monoxide in mammalian whole-body x-irradiation (ab), Feb., 315
- KONNEKER, WILFRED.** See **SMOLIK, EDMUND A.**
- KOVACH, JOHN C., AVEDIAN, VICTOR, MORALES, GEORGE, and POULOS, PETER:** Lung compartment determination (ab), Feb., 280
- KOVÁCS, ÁKOS:** Headache from subluxations of the cervical articulations (ab), June, 887
- KOVACS, LESLIE.** See **MELTZER, HERBERT**
- KOWALEWSKI, K.** See **OSBORNE, J. C.**
- KRAFT, ERNEST, and SLATER, GREGORY S.:** Excretory urography with Hypaque Sodium. Experience with 300 cases (ab), April, 617
- KRAINTZ, L.** See **SMITH, E. L.**
- KRAMER, PHILIP:** Frequency of the asymptomatic lower esophageal contractile ring (ab), Feb., 290
- KREIS, Van ALLEN.** See **KEATS, THEODORE E.**
- KREMENS, V., BERGER, S. M., and COHEN, E. M.:** Comparison of rapid intravenously and orally administered contrast mediums for routine gall-bladder study (ab), Feb., 294
- KROHMER, JACK.** See **COLE, JACK W.**
—See **THOMAS, CHARLES I.**
- KROHN, MELVIN.** See **ROSENBERG, NORMAN**
- KROLL, GEORGE.** See **SCHOENBERGER, JAMES A.**
- KRONSEIN, JOHN.** See **BECK, ROBERT E.**
- KÜNKEL, H. A.** See **SCHUBERT, G.**
- KUTHY, JOSÉ.** See **CELIS, ALEJANDRO**
- KUTZ, EUGENE R.:** Influence of histologic type on survival following radiotherapy of bronchogenic carcinoma (ab), June, 908
- KYMOGRAPHY**
—bi-axial roentgenkymography: aid in differential diagnosis of solid mediastinal tumor and aneurysm (ab), Martin Schneider and Jorge Ceballos, Feb., 286
—portable serial roentgenkymography in acute myocardial infarction (ab), J. J. Sampson et al, March, 440
—systolic expansion or aorto-diastolic displacement. Roentgenkymographic study of left atrial movements in mitral cardiopathy (ab), F. Dalith, Jan., 128

L

LABOR. See Placenta; Pelvis

LaCOUR, EDWARD G., and O'NEIL, LAWRENCE J.: Acute pneumocholecystitis. A review of the literature and a report of one case (ab), April, 610

LACRIMAL ORGANS

—sialographic differentiation of Mikulicz's disease and Mikulicz's syndrome, Philip Rubin and Byron E. Besse, Jr., April, 477
—treatment of skin tumors of inner canthus with regard to function of lacrimal ducts (ab), Hansrudolph Renfer, Jan., 143

LACTATION

—cholecystography during lactation (ab), Kaj H. Holmdahl, Feb., 295

LAINE, E., DELANDTSHEER, J. M., GALIBERT, P., and DELANDTSHEER-ARNOTT, G.: Phlebography in tumours of the hemispheres and central grey matter (ab), May, 757

LAME, EDWIN L.: Vertebral osteomyelitis following operation on the urinary tract or sigmoid. The third lesion of an uncommon syndrome (ab), March, 454

LAMINAGRAPHY. See Body-Section Roentgenography

LANDMANN, WENDELL A. See **BEST, WILLIAM R.**

LANGHAM, WRIGHT H. See **ANDERSON, ERNEST C.**

LANGMEAD, W. A. See **WETHERLEY-MEIN, G.**

LANGS, A. See **WORINGER, E.**

LANIER, RAYMOND R., WHITEHEAD, RICHARD W., and GUM, JANE H.: Augmenting effects of radiation therapy by chemotherapy and other agents (ab), June, 910

LAPIDES, JACK, and BOYD, ROBERT E.: Effect of intravenous Benadryl in allaying allergic manifestations of 70 per cent Urokon (ab), April, 617

- LARDE-ARTHEZ, C. R.** See **COHEN, SAMUEL**
- LARSEN, KAARE A., and PEDERSEN, ARNE:** Roentgenologic findings in the stomach and duodenum in cancer of the pancreas (ab), April, 608
- LARSSON, L.-G.** See **EINHORN, J.**
- LARYNX**
- contrast examination of larynx and pharynx, William E. Powers, Harry H. McGee, Jr., and William B. Seaman, Feb., 169
 - note on congenital laryngeal stridor (ab), T. G. Wilson, April, 601
- CANCER**
- indications for radical surgery, partial surgery, radiotherapy and combined surgery and radiotherapy for cancer of larynx and hypopharynx (ab), Jean Leroux-Robert, Jan., 144
- PARALYSIS**
- radiologic investigation of pharyngeal and laryngeal palsy (ab), G. M. Ardran and F. H. Kemp, May, 761
- LASZLO, DANIEL.** See **SEGEL, ELSIE P.**
- LATHROP, KATHERINE A.** See **HARPER, PAUL V.**
- LAUGHLIN, JOHN S.** See **FULLER, JOHN B.**
- LAURENT, L. E.** See **EDGREN, W.**
- LAWRENCE, G. H., and BURFORD, T. H.:** Congenital aneurysm of the superior vena cava (ab), Feb., 287
- LAWRENCE, JOHN H.:** Isotopes and nuclear radiations in experimental medicine (ab), April, 625
- LEAD**
- attenuation of 86- and 176-MEV synchrotron x-rays in concrete and lead (ab), William Miller and Robert J. Kennedy, April, 636
- LEADER, S. A.:** Delayed visualization of the gall bladder due to gastric retention (ab), May, 774
- LEBORGNE, FELIX E., LEBORGNE, RAUL, SCHAFFNER, EDUARDO, and LEBORGNE, FELIX E., Jr.:** Study of the lymphatics of the mammary gland with radioactive gold (Au-198) (ab), March, 470
- LEBORGNE, FELIX E., Jr.** See **LEBORGNE, FELIX E.**
- LEBORGNE, RAUL.** See **LEBORGNE, FELIX E.**
- LE BUS, HOWARD E.:** Unusual osteochondroses presenting diagnostic difficulty (ab), June, 898
- LECTURE KIT.** See **Education**
- LEE, IAN N.:** Pulmonary metastases (ab), May, 764
- LEE, JOHN C., HELGASON, SKULI, and SNIDER, RAY S.:** Effects of acute x-irradiation on the evoked cerebellar response (ab), Feb., 315
- LEES, F.** See **BAIRD, I. McLEAN**
- LEFÈBVRE, J., KLEIN, M. R., LEPINTRE, J., and FAURÉ, C.:** Roentgen study of spinal cord tumors in children (ab), May, 784
- LÉGER, JEAN-LOUIS.** See **RATELLE, GERMAINE**
- LEGS.** See **Extremities**
- LEHMANN, OTTO:** Fractures of the spine in children (ab), April, 611
- LEICHER, F.:** Differential diagnosis between aluminum lung and Boeck's sarcoid. A correction of the article by K. H. Ehrecke (ab), March, 438
- LEIGH, KENNETH E.** See **WRIGHT, KENNETH A.**
- LEIOMYOMA.** See **Tumors, myoma**
- LEMCZNER, MICHAEL.** See **OWEN, TREVOR**
- LENTINO, WALTER, MARCHETTO, INNOCENZO, and POPPEL, MAXWELL H.:** A modification of the routine lateral view of the chest to permit visualization of the superior mediastinum (ab), Feb., 285
- See **POPPEL, MAXWELL H.**
- PRINCIPATO, DOMINICK J., and POPPEL, MAXWELL H.:** Buckling of the carotid artery demonstrated by angiocardiology (ab), March, 442
- ZEITEL, BERTRAM E., JACOBSON, HAROLD G., and POPPEL, MAXWELL H.:** Intravenously given urographic mediums. Comparative study of eight hundred cases (ab), April, 616
- LENZI, M., and CANOSSI, G. C.:** Two years experience with a cisterno-encephalographic technic (ab), May, 759
- LEPINTRE, J.** See **LEFÈBVRE, J.**
- LEPROSY**
- bone changes (ab), D. E. Paterson, March, 453
- LEROUX-ROBERT, JEAN:** Indications for radical surgery, partial surgery, radiotherapy and combined surgery and radiotherapy for cancer of the larynx and hypopharynx (ab), Jan., 144
- LESTER, RICHARD G.** See **GOTT, VINCENT L.**
- LETSCHE, WILLIAM R.** See **KESKEY, G. RICHARD**
- LETTERER-SIWE DISEASE.** See **Reticuloendothelial System LEUKEMIA**
- acute myeloid leukemia after radioactive iodine therapy (ab), John D. Abbott et al., April, 628
 - see difference in response to titrated irradiation therapy (³²P) of patients with chronic granulocytic leukemia (ab), William H. Crosby et al., May, 788
 - vertebral changes in childhood leukemia, Bernard S. Epstein, Jan., 65
- LEUKOCYTES**
- See also **Leukemia**
 - effect of antepartum diagnostic roentgenography on white blood cell count of newborn infant, Irwin H. Kaiser and James F. Marvin, Feb., 249
 - effect of transfusions of blood showing extreme leukocytosis on survival of x-irradiated mice (ab), C. C. Congdon et al., April, 634
- LEVENE, GEORGE, and KAUFMAN, S. A.:** An improved technic for double contrast examination of the colon by the use of compressed carbon dioxide, Jan., 83
- and SCHEFF, SAUL:** Intravenous cholangiography as an aid in diagnosis of carcinoma of the head of the pancreas, May, 714
- See **SCHEFF, SAUL**
- LEVITIN, JOSEPH.** See **REICH, STANLEY B.**
- LEVY, LAURENCE F.:** Granuloma of the neck following Thorotrast angiography (ab), March, 436
- LEVY, LOUIS M., HANNOV, DONALD W., SPRAFKA, JOSEPH L., and BARONOFFSKY, IVAN D.:** A method for coronary arteriography (ab), March, 444
- LEWIS, EVAN L., and CLÉTSOWAY, RICHARD W.:** Megaloureter (ab), Feb., 301
- LEWIS, PETER M.** See **HALSTED, JAMES A.**
- LEWTAS, N. A.** See **DIMANT, STEVENS**
- LIBBY, RAYMOND L.** See **MOORE, VINCENT**
- LICH, ROBERT, Jr.:** The obstructed ureteropelvic junction, March, 337
- LICHT, ERIK DE F.:** Arterioenteric obstruction of the duodenum in adult life and adolescence (ab), April, 608
- LIDHOLM, S. O.** See **RINGERTZ, N.**
- LIEBERMAN, VERNON W.** See **BAUER, FRANZ K.**
- LIGAMENTS.** See **Spine**
- LILLEQUIST, B.:** The anatomy of the subarachnoid cisterns (ab), May, 753
- LILLEHEI, C. WALTON.** See **GOTT, VINCENT L.**
- LIMARZI, LOUIS R.** See **BEST, WILLIAM R.**
- LIND, JOHN.** See **BOESEN, IB.**
- LINDAU'S DISEASE.** See **Tumors, angioma**
- LINDBLOM, K.** See **FRANSSON, C.**
- LINDBLOM, A.** See **HELANDER, C. G.**
- LINDELL, BO, and WALSTAM, RUNE:** A new telegamma apparatus (ab), Jan., 151
- LINDGREN, E.:** Another method of vertebral angiography (ab), June, 883
- See **AZAMBUJA, N.**
- LINEAR ELECTRON ACCELERATOR.** See **Electrons**
- LINGUATULIDAE.** See **Porocephalosis**
- LIPOMAS.** See **Tumors, lipoma**
- LIPOPROTEINS.** See **Blood, lipoproteins**
- LITTLETON, JESSE T.** See **FEIST, JOHN H.**
- LIVER**
- biosynthesis of fatty acids in liver and intestine of intact normal, fasted and x-irradiated rats (ab), John G. Coniglio et al., April, 635
 - enlargement of liver in Sprague-Dawley rats following whole-body x-irradiation (ab), Helen Supplee et al., April, 635
 - plasma, tissue (liver) and urinary radioactivity after oral administration of ¹⁴C-labeled vitamin B₁₂ (ab), C. C. Booth and D. L. Mollin, May, 789
 - recording of radioactivity in blood, liver, and prostate following interstitial administration of Au¹⁹⁸ in carcinoma of prostate (ab), Wayne M. Rounds and Titus C. Evans, April, 629
 - x-irradiation and liver regeneration in partially hepatectomized rats (ab), Leon L. Gershbein, April, 635
- blood supply.** See **Portal Vein**
- treatment of primary and metastatic cancer (ab), Irving M. Ariel, March, 464
- cirrhosis**
- hepatic cirrhosis and gastro-duodenal ulcer (ab), E. de Arzúa Zulaica, Feb., 291
 - investigation of transfer rates of albumin tagged with I¹³¹ in ascites and edema. II. Studies in control subjects and patients with cirrhosis (ab), James A. Schoenberger et al., March, 469
- diseases**
- evaluation of oral cholecystography in liver disease (ab), William Mandel et al., Jan., 134
- echinococcosis**
- echinococcosis in North American Indians and Eskimos (ab), Herbert Meltzer et al., May, 765
- hernia**
- partial obstruction of inferior vena cava by herniation of liver through foramen of Morgagni, case, David Rosenblum, Arnold Nussbaum and Solomon Schwartz, March, 399
- roentgenography**
- colloidal stannic oxide; animal studies on new hepatolienographic agent, Harry W. Fischer, April, 488
 - does "laparoscopic" splenoportography indicate an advance in field of medical x-ray diagnosis? Contribution to early diagnosis of intrahepatic obstruction (ab), L. Wanagat, March, 451
 - effect of artificial gaseous distension of stomach and its role in making liver radiologically visible (ab), N. R. Konar et al., Feb., 292
 - pneumostratigraphy in investigation of left lobe of liver (ab), P. Bétoulères et al., Feb., 293
- LIVINGSTON, SHIELDS O.** See **NORTH, JOHN P.**
- LIZAMA, CARLOS.** See **WEIR, ROYAL A.**
- LLAMBES, JAUN.** See **FARIÑAS, LAURA**
- LLOYD, G. A. S.:** X-ray manifestations of early malignant gastric ulceration (ab), March, 446

- LLOYD, JAMES.** See **CLATWORTHY, H. WILLIAM, Jr.**
- LOCKHART, L. B., Jr.** See **KING, P.**
- LOCKWOOD, IRA H., and CHAPMAN, SAMUEL B.:** Therapy of carcinoma of the urinary bladder (ab), Jan., 146
- LODGE, THOMAS:** Bone, joint and soft tissue changes following paraplegia (ab), May, 780
- LOEFFLER, R. KENNETH.** See **COLLINS, VINCENT P.**
- LÖFGREN, F. OLOF:** Vertebral angiography in the diagnosis of hydrocephalus and differentiation between stenosis of the aqueduct and cerebellar tumour (ab), May, 757
- LÖRINC, P.** See **BORIS, A.**
- LOITMAN, BERNARD S., and CHIAT, HAROLD:** Urethritis cystica and pyelitis cystica. A review of cases and roentgenologic criteria, March, 345
- LOMBARD, L. S.** See **ALLAM, M. W.**
- LOMBARDI, G., and PASSERINI, A.:** Extradural cysts of the spine (ab), March, 453
- LONGACRE, J. J.:** Surgical management of local prostatic adenoma effects (ab), May, 792
- LOONEY, W. B., MALETSKY, C. J., HELMICK, MARIE, REARDON, JOHN, COHEN, JONATHAN, and GUILD, WARREN:** The artificial kidney and ion-exchange resins as possible methods of removing radioelements from the body, Feb., 255
- LOVELL, B. K.** See **NORTH, JOHN P.**
- LOW-BEER, BERTRAM V. A., and BELL, H. GLENN:** Surgical and radiation treatment of carcinoma of the breast. A new concept (ab), April, 619
- See **NG, ELMER**
- LOWMAN, ROBERT M.** See **DAVIS, LEONARD**
- LUCAS, H. F., Jr.:** A stable, low-background, high-efficiency scintillation counter for analysis of low levels of radon concentrated by adsorption on charcoal, Feb., 258
- LUNGCHETTI, D.** See **SALOTTI, AD.**
- LUNGS**
See also Arteries, pulmonary; Bronchi; Bronchiectasis; Pleura
—elimination of radioactive barium sulfate particles from lung (ab), H. Cember et al, May, 796
—fatal pulmonary insufficiency due to radiation effect upon lung (ab), Daniel J. Stone et al, June, 915
—retention of radon decay products in human lungs (ab), Cestmir Jech, May, 793
blood supply. See also Arteries, pulmonary
—angiopulmonary study of lesser circulation in mitral stenosis (ab), A. Actis-Dato et al, May, 768
—secondary vascular changes in lungs (ab), Marcy L. Sussman and Thomas T. Frost, Feb., 281
—selective angiopneumography and correlative study of bronchography and histopathologic findings in tuberculous fibrothorax (ab), Raúl Cicero et al, Jan., 124
—total anomalous pulmonary return; analysis of 30 cases (ab), Vincent L. Gott et al, Feb., 288
calcification. See Histoplasmin and Histoplasmosis; Lungs, cancer
cancer. See also Bronchi, cancer
—calcification within solitary pulmonary nodule; fallible sign of benignity (ab), Edgar W. Davis et al, June, 890
—cancer of thyroid, with metastases to lungs. Condition shown by scintigram in absence of definite x-ray findings (ab), Boris Catz and Paul Starr, Jan., 150
—differential x-ray diagnosis of carcinoma (ab), Ernst A. Schmidt, Jan., 125
—evaluation of different radiologic methods (Dionosil, mucosography, tomography) in diagnosis of carcinoma (ab), Laura Fariñas et al, June, 889
—importance of thoracic duct in spread of malignant disease (ab), Alejandro Celis et al, Jan., 126
—primary pulmonary carcinoma associated with active pulmonary tuberculosis (ab), F. Bender, June, 888
—pulmonary adenomatosis (alveolar-cell carcinoma) (ab), A. Fanconi, Feb., 281
—pulmonary metastases (ab), Ian N. Lee, May, 764
—radiotherapy: results in selected group of cases (ab), Joseph Smart and Gwen Hilton, May, 785
—scleroderma (progressive systemic sclerosis) associated with cancer of lung; brief review and report of case (ab), Sigmundur M. Jonsson and Joseph M. Houser, June, 889
—supervoltage roentgen therapy (ab), T. A. Watson, Jan., 144
—2-million volt irradiation therapy for inoperable carcinoma (ab), Ruth J. Cuttmann, Feb., 303
—unusual roentgenologic aspects of pulmonary metastases (ab), P. Wellens, Feb., 282
cavitation
—experimental staphylococcal bullous pneumopathy (ab), R. Herbeuval and G. Deby, May, 767
collapse
—brief clinical consideration of pathogenesis of "functional" atelectasis (ab), Carlo Marino, Jan., 126
—etiology and radiation treatment of middle-lobe syndrome (ab), O. Fischedick, March, 463
—large pneumothorax and associated massive collapse of homolateral lung due to intrabronchial obstruction; case, Sidney W. Nelson, March, 411
—localization of pulmonary collapse-consolidation (ab), C. J. Hodson, May, 763
—middle lobe atelectasis of neuroreflex origin (?) (ab), Carlo Palamidessi, Jan., 126
cysts. See also Lungs, tumors
—congenital intralobar sequestration with anomalous artery from aorta (ab), Vidar Jensen and Aage Wolff, March, 437
—giant air cyst(s) as sequela of pulmonary tuberculosis (ab), John L. Shek et al, May, 766
—preoperative diagnosis of sequestration by aortography (ab), Leo J. Kenney and William R. Eyer, Feb., 281
diseases
—chronic localized pulmonary brucellosis (ab), Lyle A. Weed et al, May, 765
—histoplasmosis. See Histoplasmin and Histoplasmosis
—pleuropulmonary tularemia: its roentgen manifestations, John M. Dennis and Robert P. Boudreau, Jan., 25
—pneumoconiosis. See Pneumoconiosis
—pneumonitis. See Pneumonitis
—Salmonella bacteremia: case with military lung lesions and spondylitis, R. H. Greenspan and S. B. Feinberg, June, 860
—sarcoidosis. See Sarcoidosis
—study of effects on lung of industrial exposure to zirconium dusts (ab), C. E. Reed, May, 764
echinococcosis
—echinococcosis in North American Indians and Eskimos (ab), Herbert Meltzer et al, May, 765
emphysema
fibrosis
—differential diagnosis of fibrosing lesions, William R. Mitchell and Boyer M. Brady, Jan., 36
—diffuse progressive interstitial fibrosis (Hamman-Rich syndrome) (ab), G. Schröder and H. Andersch, April, 601
—factors influencing radiological attack rate of progressive massive fibrosis (ab), A. L. Cochrane and W. E. Miall, March, 438
hemorrhage
—recurrent pulmonary hemorrhage with hemosiderosis; so-called idiopathic pulmonary hemosiderosis (ab), André J. Bruwer et al, May, 766
infarction
—temporary thrombotic state. Application of this concept to therapy of recurrent thrombo-embolism, with bacteriologic and roentgenologic considerations in the differential diagnosis of pulmonary infarction and pneumonia (ab), Stanford Wessler et al, Jan., 130
middle-lobe syndrome. See Lungs, collapse
mycosis. See Aspergillosis; Blastomycosis; Coccidioidomycosis; Histoplasmin and Histoplasmosis; Nocardiosis
pathology
—chronic pulmonary infiltration with eosinophilia in the asthmatic (5 personal observations, including 1 with histopathologic analysis) (ab), J. Turial et al, Feb., 283
—circumscribed pulmonary lesions in periarthritis nodosa and Wegener's granulomatosis (ab), James V. Rogers, Jr. and Albert E. Roberto, May, 765
—familial dysautonomia: pulmonary manifestations (ab), Ralph E. Moloshok and John E. Moseley, Jan., 127
—hyaline membrane disease: preclinical roentgen diagnosis. Planned study, S. B. Feinberg and M. E. Goldberg, Feb., 185
—pathological anatomy of changes involving pulmonary parenchyma after high doses of x-rays (ab), Harold Henzi, June, 915
—pulmonary tuberous sclerosis; case (ab), André J. Bruwer et al, Feb., 283
—roentgenographic findings in familial dysautonomia, Rob H. Kirkpatrick and Conrad M. Riley, May, 654
roentgenography. See also Bronchi; Tuberculosis, in children;
Tuberculosis, Pulmonary; other subheads under Lungs
—basal horizontal lines on chest radiographs: significance in heart-disease (ab), R. E. Rossall and A. J. Cunnig, April, 603
—coin lesions (ab), J. C. Gerrits, May, 764
—"coin" lesions (ab), William B. Ford et al, Jan., 125
—findings in respiratory problems of infants (ab), S. B. Feinberg, March, 439
—importance of pulmonary nodule (ab), Donald L. Paulson, Jan., 125
—posteroanterior roentgenogram in two types of anomalous pulmonary venous connection (ab), André J. Bruwer, May, 770
—radiology of lung in left heart failure (ab), D. S. Short, Feb., 287
—roentgenologic method for demonstration of bronchopulmonary segments in fully expanded cadaver lungs in situ (ab), Kuo-York Chynn and L. R. Sante, Feb., 280
—significance of coin lesions (ab), Paul W. Johnston and Joseph A. Weinberg, May, 764
—three cases of circumscribed pulmonary opacities simulating tumor (ab), J. D. Bristow and E. C. Gauden, May, 765
—use of different tube shifts in lung tomography, Hans Saling and Hannah Friedman-Baron, Feb., 209
sequestration. See Lungs, cysts
tuberculosis. See Tuberculosis, Pulmonary
tumors
—massive cystic pulmonary hamartoma: 2 cases (ab), Robert C. Jackson et al, Feb., 282
—primary sarcoma of bronchus and lung (ab), Lew A. Hochberg and Philip Crastopol, June, 889
—three cases of circumscribed pulmonary opacities simulating tumor (ab), J. D. Bristow and E. C. Gauden, May, 765
volume. See Vital Capacity
LUTTERBECK, EUGENE F., and HUMMON, IRVIN F., Jr.: Clinical experiences with the strontium 90 applicator (ab), Jan., 152

LUTTWAK, EDMUND M. See SALTZ, NATHAN J.
 LYLE, F. M., and KING, PHILIP S.: Treatment of peritoneal and pleural mesothelioma and metastatic malignancy with radioactive colloidal gold (ab). April, 628

LYMPH NODES

- calcification of regional nodes following BCG vaccination (ab). Samuel C. Stein and Martin J. Sokoloff, Jan., 124
- few cases of glandular-bronchial fistula (ab). Armando Pinheiro and Fernando Outeiro, Jan., 127
- histopathological study of lymph nodes irradiated with colloidal Au¹⁹⁸ (ab). William M. Christopherson and Harold F. Berg, Feb., 311
- lymph node-fever relationship in lymphoma (ed). Don E. Matthiesen, May, 739
- lymphadenography: new method for visualization of enlarged lymph nodes and lymphatic vessels; preliminary report (ab). Sven Bruun and Arnfinn Engeset, March, 461

CANCER

- lymphatic dissemination of radiogold in presence of lymph node metastases (ab). Colin G. Thomas, Jr., May, 788

LYMPHATIC SYSTEM

- correlation of early radiation changes in lymphatic tissues with antitoxin-producing ability (ab). William L. Williams et al, April, 636
- diagnostic possibilities of lymphangiography (ab). R. Gergely et al, June, 906
- importance of thoracic duct in spread of malignant disease (ab). Alejandro Celis et al, Jan., 126
- lymphadenography: new method for visualization of enlarged lymph nodes and lymphatic vessels; preliminary report (ab). Sven Bruun and Arnfinn Engeset, March, 461
- lymphatic dissemination of radiogold in presence of lymph node metastases (ab). Colin G. Thomas, Jr., May, 788
- study of lymphatics of mammary gland with radioactive gold (Au¹⁹⁸) (ab). Felix E. Leborgne et al, March, 470

LYMPHOGANULOMATOSIS. See Hodgkin's Disease

LYMPHOMA. See Tumors, lymphoma

LYMPHOSARCOMA. See Sarcoma, lymphosarcoma; Tumors, experimental

LYNCH, P. R. See OPPENHEIMER, M. J.

LYNN, R. E. See CHIN, E. F.

LYONS, HAROLD A., and MANNIX, EDGAR P., Jr.: Successful resections for bilateral pulmonary arteriovenous fistulas (ab). March, 444

M

MAASS, LYMAN. See BOLDREY, EDWIN

McAFEE, JOHN G.: A survey of complications of abdominal aortography. June, 825

—and WILLSON, JAMES K. V.: A review of the complications of translumbar aortography (ab). March, 443

McBRIDE, BERT H. See McLAURIN, ROBERT L.

McCANN, J. SYDNEY, and PORTER, D. C.: Calcification of the aorta as an aid to the diagnosis of syphilis (ab). Feb., 288

McCARTY, COLLIN S. See FLY, ORCENETH A., Jr.

McCOMBS, ROLLIN K.: Proton irradiation of the pituitary and its metabolic effects. Memorial Fund lecture, June, 797

McCONAHEY, WILLIAM M. OWEN, CHARLES A., Jr., and KEATING, F. RAYMOND, Jr.: A clinical appraisal of radioiodine tests of thyroid function (ab). April, 626

McCORMACK, JOSEPH G.: Paraplegia secondary to abdominal aortography (ab). April, 605

McCORMICK, DONALD B. See CONIGLIO, JOHN G.

McCREA, ALICE L. See JENNINGS, W. ALAN

McCREA, L. See BACON, H. E.

MacDONALD, GEORGE E., and HOYT, LYMAN H.: Corticotropin (ACTH) gel in treatment of irradiation enterocolitis. Report of two cases (ab). June, 917

MacDONALD, J. C. F. See MILLAR, OWEN

MacDONALD, JOHN R. See JACKSON, ROBERT C.

McELHINNEY, J. See ZENDLE, B.

McGEE, HARRY H., Jr. See POWERS, WILLIAM E.

MACIAS, BENJAMIN. See GARCIA CASTAÑEDA, MÁXIMO

MacINTYRE, WILLIAM J. See THOMAS, CHARLES I.

MACK, ROBERT E., WELLS, HERSCHEL J., and POLLACK, ROBERT: An in vivo method for the determination of cardiac output (ab). Feb., 245

McKAY, J. W. See ROBY, H. R.

McKEOWN, JAMES E. See HALLIGAN, EARL J.

MacKINNON, HECTOR N. See FLY, ORCENETH A., Jr.

McLAURIN, ROBERT L., and McBRIDE, BERT H.: Traumatic intracerebral hematoma. Review of 16 surgically treated cases (ab). March, 435

McMULLAN, FRANCIS H., and ZELIGMAN, ISRAEL: Perifolliculitis capitis abscedens et suffodiens: its successful treatment with x ray epilation (ab). May, 787

MACNAB, IAN. See HARRISON, M. C.

MACPHERSON, JOHN, and WILSON, JOHN K.: Radiological study of the placental stage of labour (ab). April, 614

McRAE, DONALD L.: Asymptomatic intervertebral disc protrusions (ab). May, 782

MAGGIPIRTO, B. See ROSSI, L.

MAGLIONE, A. A. See BOBBELLI, F. J.

MAGNIFICATION TECHNIQUES. See Roentgen Rays, technic

MAHONEY, J. P. See BUSH, J. A.

MALETSKOS, C. J. See LOONEY, W. B.

MALLET-GUY, PIERRE, and ROSE, J. DUDFIELD: Pre-operative manometry and radiology in biliary tract disorders (ab). May, 775

MALSKY, STANLEY. See ROSWIT, BERNARD

MANDEL, WILLIAM, GAINES, L. M., Jr., and MARILLEY, R. J., Jr.: Evaluation of oral cholecystography in liver disease (ab). Jan., 134

MANN, LAWRENCE S., KIRSH, ISRAEL E., EISEN, JESSE, and FAMILARO, JOHN E.: The roentgenogram in perforated peptic ulcer (ab). Feb., 291

MANNIX, EDGAR P., Jr. See LYONS, HAROLD A.

MANOMETRY. See Biliary Tract

MARCHETTA, FRANK C., and MATTICK, WALTER L.: Carcinoma of the tongue. Treatment and results without radical surgery (ab). June, 907

MARCHETTO, INNOCENZO. See LENTINO, WALTER

MARCUS, PHILIP I. See PUCK, THEODORE T.

MARFAN'S SYNDROME

—cardiovascular changes in dystrophia mesodermalis congenita Marfan (ab). P. Amundsen and I. Holter, March, 441

MARGOLIS, G., TARAZI, A. K., and GRIMSON, K. S.: Contrast medium injury to the spinal cord produced by aortography. Pathologic anatomy of the experimental lesion (ab). May, 770

MARGULIS, ALEXANDER R. See NICE, CHARLES M., Jr.

MARILLEY, R. J., Jr. See MANDEL, WILLIAM

MARINELLI, L. D. See GUSTAFSSON, P. F.

—See MILLER, C. E.

MARINO, CARLO: Brief clinical consideration of the pathogenesis of "functional" atelectasis (ab). Jan., 126

MARKOWITZ, H. A. See DUDLEY, H. C.

MARMOLEJO, AUGUSTO. See ARANGO, ORIOEL

MARSHAK, RICHARD H., BLUM, S. DANIEL, and ELIASOPH, JOAN: Pneumatoxis involving the left side of the colon (ab). June, 897

—and ELIASOPH, JOAN: Pneumatoxis coli (ab). Jan., 133

MARTIN, F. A. See WEBSTER, J. E.

MARTINEZ FABRE, CARLOS. See GARCÍA CASTAÑEDA, MÁXIMO

MARTNER, EDGAR E., CORRIGAN, KENNETH E., CHARBENEAU, HAROLD P., and SOSIN, ALLEN: A study of the uptake of iodine (I-131) by the thyroid of premature infants (ab). Feb., 309

MARVIN, JAMES F. See KAISER, IRWIN H.

MASS SURVEYS. See Breast, cancer; Mediastinum, cysts; Tuberculosis, pulmonary, mass roentgenologic surveys

MATAS, MATTHEW. See MELTZER, HERBERT

MATHEWS, WILLIAM H. See MILLS, EDWARD S.

MATSCHEKE, SIEGFRIED. See EICHORN, HANS-JÜRGEN

MATTICK, WALTER L. See MARCHETTA, FRANK C.

MAUDSLEY, ROY H., and STANSFELD, ALFRED G.: Non-osteogenic fibroma of bone (fibrous metaphysal defect) (ab). June, 898

MAURER, H.-J.: Moving field therapy of gynaecological tumours in the pelvis (ab). June, 909

MAXWELL, DAVID M. W.: Granulosa cell tumor producing symptoms four years following radium menopause (ab). Feb., 312

MAXWELL, GEORGE M. See ROWE, GEORGE G.

MAYO, HENRY W., Jr. See ASHMORE, J. D.

MEANEY, THOMAS F., and HAYS, ROBERT A.: Roentgen manifestations of psoriatic arthritis, March, 403

MECONIUM

—meconium ileus. Ronald E. Herson, April, 568

—meconium ileus: clinical study of 20 surviving patients (ab). Harry Schwachman et al, Jan., 132

—meconium plug syndrome (ab). H. William Clatworthy, Jr., et al, March, 448

MEDIASTINUM

—congenital anomalies of large mediastinal vessels (ab). Franco Chiariotti and Carlo Picchio, Feb., 289

—pendular motion of mediastinum (ab). Philip Samet and William Anderson, April, 602

CANCER

—mediastinal parathyroid carcinoma with metastases; report of case and review of literature, Irving Weissman, James P. Worden and James M. Christie, March, 352

CYSTS

—branchiogenic intrathoracic mediastino-thymic cyst (ab). Z. V. Skokan and J. Stolz, May, 767

—mediastinal tumors and cysts (discovered by routine mass radiography) (ab). N. Ringertz and S. O. Lidholm, Feb., 286

roentgenography. See also Mediastinum, tumors

—mediastinal pneumography (ab). Harold J. Isard et al, Feb., 285

—modification of routine lateral view of chest to permit visualization of superior mediastinum (ab). Walter Lentino et al, Feb., 285

TUMORS

—bi-axial roentgenkymography: aid in differential diagnosis of solid mediastinal tumor and aneurysm (ab). Martin Schneider and Jorge Ceballos, Feb., 286

—in children (ab). Edward B. Singleton and E. Wiley Biles, June, 891

—mediastinal tumors and cysts (discovered by routine mass radiography) (ab). N. Ringertz and S. O. Lidholm, Feb., 286

—posterior hemangiomas, S. B. Feinberg, Jan., 90

- MEGACOLON.** See Colon, dilatation
MEGALOURETER. See Ureters, dilatation
MEIJER, J. W. A. See STANBURY, JOHN B.
MELLINS, HARRY Z. See BERK, J. EDWARD
MELTZER, HERBERT. KOVACS, LESLIE, ORFORD, THOMAS, and MATAS, MATTHEW: Echinoscissus in North American Indians and Eskimos. (ab), May, 765
MELTZER, JAY L. Pericardial effusion in generalized scleroderma (ab), Feb., 287
MENINGES
 —anatomy of subarachnoid cisterns (ab), B. Liliequist, May, 753
 —changes in size of subarachnoid spaces after insufflation of air (ab), Jan Jirout, May, 753
 —contribution to methods of filling posterior fossa and adjoining cervical subarachnoid space with small quantities of air (ab), H. Verbiest, June, 883
 —diagnostic value of encephalographic examination of subarachnoid space (ab), Giovanni Ruggiero, May, 753
 —meningoencephalitis due to Brucella abortus (ab), P. Ebeling and E. Graeme Robertson, April, 600
 —subdural collections of fluids in infants and children. II. Study with radioactive sodium phosphate (P^{32}) (ab), R. M. N. Crosby and Robert E. Bauer, Jan., 121
tumors
 —radiologic diagnosis of intraventricular meningiomas (ab), Bengt Falk, May, 759
MENINGIOMAS. See Meninges, tumors
MENINGOENCEPHALITIS. See Meninges
MENOPAUSE
 —granulosa-cell tumor producing symptoms 4 years following radium menopause (ab), David M. W. Maxwell, Feb., 312
 —radiation menopause or hysterectomy. Part II. Mortality, morbidity, and subsequent pelvic cancer (ab), A. C. Turnbull, Feb., 305
MERCAPTOETHYLAMINE. See Roentgen Rays, injurious effects
MERRILD-HANSEN, B. See BOESEN, IB
MERTEN, CHARLES W., FINBY, NATHANIEL, and STEINBERG, ISRAEL: Antemortem diagnosis of syphilitic aneurysm of the aortic sinuses. Report of nine cases (ab), Jan., 129
MESODERMAL TISSUE
 —cardiovascular changes in dystrophia mesodermalis congenita Marfan (ab), P. Amundsen and I. Holter, March, 411
MESOTHELIOMA. See Tumors, mesothelioma
METABOLISM
 —See also Blood, lipoproteins; Copper
 —proton irradiation of pituitary and its metabolic effects; Memorial Fund lecture, Rollin K. McCombs, June, 797
METZGER, J. See FISCHGOLD, H.
MEURK, M. L., JACOBSON, A., and SCHULTZ, R. J.: Dosimetry of interstitial implants, Feb., 256
MEYER, LEO M.: Blood volume determinations with radioactive chromium (Cr^{51}) labeled erythrocytes. Feasibility of routine total red blood cell volume determinations in a general hospital (ab), Feb., 311
MIALL, W. E. See COCHRANE, A. L.
MIDDLEMISS, J. H. See BROWN, J. SCOTT
MIKULICZ'S DISEASE; MIKULICZ'S SYNDROME. See Salivary Glands
MILITARY MEDICINE
 —malabsorption syndrome in military personnel in Puerto Rico (ab), Frank H. Gardner, May, 772
MILLAR, OWEN, and MacDONALD, J. C. F.: Radioactive gold in malignant effusions (ab), March, 470
MILLER, C. E., MARINELLI, L. D., and STEINGRABER, O. J.: Analysis of the Cs^{137} content in man due to radioactive fallout, Jan., 105
MILLER, C. PHILLIP. See HAMMOND, CAROLYN W.
MILLER, D. V. See BOREN, H. G.
MILLER, EARL. See BOLDREY, EDWIN
MILLER, J. E. See BROOKSALER, FRED
MILLER, JAY. See SUSSMAN, RALPH M.
MILLER, R. M. See HUGHES, H. A.
MILLER, WILLIAM, and KENNEDY, ROBERT J.: Attenuation of 86- and 176-Mev synchrotron x-rays in concrete and lead (ab), April, 636
MILLS, EDWARD S., and MATHEWS, WILLIAM, H.: Interstitial pneumonitis in dermatomyositis (ab), Feb., 284
MILLS, W. A. See UPTON, A. C.
MINES AND MINERS
 —chronic bronchitis, emphysema, and bronchial spasm in bituminous coal workers; epidemiological study (ab), John Pemberton, May, 763
MIKON. See Pyelography
MITCHELL, DAVID J.: Basic combined cholecystangiography (ab), Jan., 136
MITCHELL, NATHAN. See RABINOVITCH, JACOB
MITCHELL, ROBERT E., JR., TITTLE, C. ROBERT, and BOCKUS, H. L.: Nephrocalcinosis in patient with duodenal ulcer disease. Report of a case associated with parathyroid adenoma (ab), April, 615
MITCHELL, T. G. See DUDLEY, H. C.
MITCHUM, WILLIAM R., and BRADY, BOYER M.: Differential diagnosis of fibrosing lung lesions, Jan., 36
MITRAL VALVE
 —angiocardigraphic observations of intracardiac flow in the normal and in mitral stenosis (ab), Louis A. Soloff et al, Jan., 128
 —angiopulmographic study of lesser circulation in mitral stenosis (ab), A. Actis-Dato et al, May, 768
 —basal horizontal lines on chest radiographs: significance in heart disease (ab), R. E. Rossall and A. J. Gunning, April, 603
 —late follow-up study of radiologic changes after valvuloplasty (ab), John E. Gary, March, 441
 —mitral stenosis associated with anomalous pulmonary venous drainage into left superior vena cava (ab), M. M. Zion, March, 441
 —mitral-valve disease: radiologic approach to physiologic diagnosis (ab), James B. Dealy, Jr., March, 441
 —radiographic estimation of pulmonary artery pressure in mitral valvular disease, George Jacobson, Leonard H. Schwartz and Marcy L. Sussman, Jan., 15
 —status of 50 patients four and a half to seven years after mitral commissurotomy (ab), O. Henry Janton et al, June, 891
 —systolic expansion or aorto-diastolic displacement. Roentgenkymographic study of left atrial movements in mitral cardiopathy (ab), F. Dalith, Jan., 128
 —transventricular and aortic angiocardiology and physiologic studies in dogs with experimental mitral and aortic insufficiency (ab), Robert J. Wilder et al, May, 771
MOBERG, CARL H. See BROWN, CHARLES H.
MOE, JOHN H. See SABANAS, ALVINA O.
MOERSCH, HERMAN J. See HABEIN, HAROLD C., Jr.
MOIR, T. W., PRITCHARD, W. H., and FORD, A. B.: Early disappearance of I^{131} serum albumin from the circulation of edematous subjects and its implications in the clinical determination of the blood volume (ab), March, 469
MOLLIN, D. L. See BOOTH, C. C.
MOLLURA, JOSEPH L., and GOLDFEDER, ANNA: Alkaline phosphatase activity in various mouse tissues following total body x-irradiation (ab), June, 917
MOLNAR, WILLIAM. See CRAWFORD, PATRICK
MOLOSHOK, RALPH E., and MOSELEY, JOHN E.: Familial dysautonomia: pulmonary manifestations (ab), Jan., 127
MONGOLISM
 —mongolism (mongoloid deficiency) during early infancy—some newly recognized diagnostic changes in pelvic bones (ab), John Caffey and Steven Ross, March, 456
MONROE, JAMES. See ZINN, BERKELEY
MOORE, LOLITA. See GERSHON-COHEN, J.
 —See INGLEBY, HELEN
MOORE, THOMAS C.: Congenital intrinsic duodenal obstruction. Report of 32 cases (ab), June, 895
MOORE, VINCENT, GAMBLE, DEAN, and LIBBY, RAYMOND L.: Experiences with radioactive chromic phosphate in urological tumors (ab), Feb., 311
MOOS, W. S.: Basic aspects of radiation theory (ab), April, 622
 —FULLER, J. E., HENDERSON, W. J., DALLENBACHER, F., and HARVEY, R. A.: Lethal effects on rats of single multiple exposures of 400-kv and 22-Mv x-radiation (ab), Feb., 313
 —See SANDBERG, GLEN
MORALES, GEORGE. See KOVACH, JOHN C.
MORGAGNI'S FORAMEN. See Hernia, diaphragmatic
MORGAN, JASPER E. See ELLINGER, FRIEDRICH
MORPHINE
 —advantages and disadvantages of morphine effect combined with Bilgrafin examination (ab), A. Boris and P. Lörinc, Jan., 136
 —bile ducts of cholecystectomized patients with and without dyskinesia before and after morphine injection. Preliminary report (ab), Eric Gunnarson, Feb., 294
 —pharmacoradiography of stomach (ab), J. Pfeiffer, Feb., 292
MORRIS, C. See COPE, E.
MORRIS, SASHA R. See FORREST, A. P. M.
MORRISON, M. T. See JOHNS, H. E.
MORRISON, R., NEWBERRY, G. R., and DEELEY, T. J.: Preliminary report on the clinical use of the Medical Research Council 8 MeV linear accelerator (ab), Feb., 307
MOSCOVITZ, L. See WILDER, ROBERT J.
MOSELEY, JOHN E.: Radiographic demonstration of cholelith cast by oral cholecystography, June, 849
 —See MOLOSHOK, RALPH E.
MOSSER, DONN G. See ENGELS, EDWARD P.
MOSTOFI, F. K.: A study of 2078 patients with initial carcinoma of the bladder. I. Survival rates. II. Survival rates in relation to therapy (ab), Jan., 146
MOULON, MARIO. See CICERO, RAUL
MOUNT, LESTER A., and TAVERAS, JUAN M.: Cerebral angiographic studies following surgical treatment of intracranial aneurysms. Angiographic evaluation of results (ab), June, 882
MOVING FIELD THERAPY. See Roentgen Therapy; Uterus, cancer
MOVIUS, HERBERT J. See ISAAC, FRANK
MOWATT, KEITH S., and STEVENS, KEITH, A.: Afterloading—a contribution to the protection problem (ab), May, 787
MOXON, C. P. See DIMANT, STEVENS
MUCOSOGRAPHY. See Lungs, cancer
MUCOUS MEMBRANES
 —irradiation of advanced cancer of head and neck through grid. Part I. Study of absorbed dose by observation of skin and mucosal reactions, Milton Friedman and Alexander W. Pearlman, June, 852
MÜLLER, O. See AMUNDSEN, A. K.
MUETHER, RAYMOND O. See SMOLIK, EDMUND A.

- MUGLER, FREDERICK R., Jr.** See **BAUER, FRANZ K.**
- MULLAN, JOHN F.** See **HARPER, PAUL V.**
- MULLER, W. H.**: Otto pelvis. Report of two cases associated with labour (ab), April, 614
- MUMPS**. See Salivary Glands
- MUNISWAMY, M.** See **REDDY, D. J.**
- MURISON, C. A., and HUGHES, H. A.**: Physical measurements on a 4-MeV linear accelerator. March, 367
- MURPHY, D. J. L.** See **DON, CONWAY**
- MURPHY, THOMAS O., SANDHAUS, SOL, and RYAN, JOSEPH M.**: Congenital peripheral arteriovenous communications. Use of femoral artery to heart circulation time in diagnosis (ab), June, 893
- MURPHY, WALTER T.**: Primary vaginal cancer: irradiation management and end-results, Feb., 157
- MUSCLES**
See also Dystrophy, Muscular
—abnormal swallowing in central-nervous-system and neuromuscular disease (ab), Maxwell H. Poppel et al, Jan., 123
—bone, joint and soft tissue changes (ossification of muscle) following paraplegia (ab), Thomas Lodge, May, 780
- MYCOSIS**
See also Aspergillosis; Blastomycosis; Coccidioidomycosis; Histoplasmosis and Histoplasmosis; Nocardiosis
—joint and bone disease due to mycotic infection (ab), Elam C. Toone, Jr., and John Kelly, Jan., 138
- MYELOGRAPHY**. See Spinal Canal Roentgenography; Spine, intervertebral disks
- MYELOMA**. See Bones, marrow
- MYERS, GORDON D.** See **SHEK, JOHN L.**
- MYHRE, JON R.**: Arteriovenous fistula of the renal vessels. A case report (ab), June, 903
- MYOCARDIUM**. See Heart
- MYOSITIS**. See Dermatomyositis
- N**
- NADOLNY, G.**: Teleroentgenotherapy in the treatment of neoplastic metastases (ab), Jan., 147
- NAGAREDA, C. SUSAN**. See **HIRSCH, BARBARA B.**
- NAGLE, W. WILLIAM, HOPE, JOHN W., and BONGIOVANNI, ALFRED M.**: Congenital goiter, April, 526
- NAKAYAMA, KOMEI**: Diagnostic significance of radioactive isotopes in early cancer of the alimentary tract, especially the esophagus and the cardia (ab), April, 630
- Pancreaticosplenectomy combined with gastrectomy in cancer of the stomach (ab), June, 894
- NASH, FRANCIS P.** See **SMOLIK, EDMUND A.**
- NATIONAL BUREAU OF STANDARDS**
—addendum to Radiation Handbook 60, June, 872
—new Radiation Handbook (62), June, 872
—x-ray studies of photographic film: National Bureau of Standards, U. S. Department of Commerce, March, 422
- NATIONAL COMMITTEE ON RADIATION PROTECTION**
—maximum permissible radiation exposures to man: preliminary statement, Feb., 260; addendum to Radiation Handbook 60, June, 872
- NAVICULAR BONE**. See Scaphoid Bone, Carpal
- NECK**
—granuloma of neck following thorotrast angiography (ab), Laurence F. Levy, March, 436
—irradiation of advanced cancer of head and neck through a grid. I. Study of absorbed dose by observation of skin and mucosal reactions, Milton Friedman and Alexander W. Pearlman, June, 852
- NEEDY, CARL**. See **CARTER, JOHN H.**
- NEGROES**
—bone changes in Kaposi's sarcoma: analysis of 15 cases occurring in Bantu Africans (ab), A. G. M. Davies, May, 779
—dysplasia epiphysealis multiplex: case in Bantu child (ab), E. Cope et al, May, 779
- NELSON, ROBERT E.** See **SPENSLEY, ROBERT D.**
- NELSON, SIDNEY W.**: Large pneumothorax and associated massive collapse of the homolateral lung due to intrabronchial obstruction. A case report, March, 411
- NELSON, THOMAS G., and BOWERS, WARNER F.**: Volvulus of the cecum and sigmoid colon. An analysis of nine cases (ab), Feb., 292
- NEMET, A., and COX, W. F.**: Improvement of definition by x-ray image magnification (ab), April, 618
- NEO-JOPAX**. See Cardiovascular System, roentgenography; Pyelography
- NEPHROCALCINOSIS**. See Kidneys
- NEPHROGRAPHY**. See Pyelography
- NERVES**
See also Nervous System, Sympathetic; Paraplegia
—acoustic
—segmental radiography of internal auditory canal in neurinomas of eighth nerve (ab), H. Fischgold et al, May, 761
—eighth. See Nerves, acoustic
—trigeminal
—cerebral angiography in encephalo-trigeminal angiomas, Charles M. Poser and Juan M. Taveras, March, 327
- NERVOUS SYSTEM**. See Brain; Cerebellum; Nerves; Nervous System, Sympathetic; Spinal Cord; Tumors, neuroblastoma
- NERVOUS SYSTEM, SYMPATHETIC**
See also Sympathectomy
—familial dysautonomia: pulmonary manifestations (ab) Ralph E. Moloshok and John E. Moseley, Jan., 127
—roentgenographic findings in familial dysautonomia, Rob H. Kirkpatrick and Conrad M. Riley, May, 654
—tumors. See also Tumors, neurinoma
—radiologic picture of intrathoracic tumors (ab), Leonardo Papagni, March, 439
- NESBIT, REED M.**: Diagnosis of intermittent hydronephrosis: importance of pyelography during episodes of pain (ab), March, 457
- NESBITT, TOM E., BOURNE, N. W., and BABBITT, D. P.**: Hypaque Sodium, a new urographic contrast medium (ab), June, 904
- NETSKY, MARTIN G., SHAPIRO, JEROME, HOFFMAN, MARILYN, CORSENTINO, B., FREID, J. R., and ZIMMERMAN, H. M.**: Effect of single doses of roentgen radiation on experimentally induced gliomas: with a critical review of the effects of roentgen radiation on gliomas in man (ab), June, 917
- NEUENSCHWANDER, H., and RENFER, HANSRUDELPH:** Contributions to cerebral angiography (ab), May, 758
- NEURALGIA**
—roentgenographic findings in trigeminal neuralgia (ab), W. James Gardner et al, June, 885
- NEURINOMAS**. See Tumors, neurinoma
- NEUROBLASTOMA**. See Tumors, neuroblastoma
- NEUTRONS**
—comparative mortality following single whole-body exposures of mice to fission neutrons and Co^{60} gamma rays, Howard H. Vogel, Jr., John W. Clark and Donn L. Jordan, March, 386
—cyclotron neutron and γ -ray dosimetry for animal irradiation studies (ab), E. Tochlin et al, Feb., 316
—effects of total-body fast neutron irradiation in dogs, (ab), V. P. Bond et al, Feb., 316
—neutron capture therapy: slow neutron depth distribution measurements in tissue (ab), E. E. Stickley, Jan., 150
—neutron-insensitive gamma-ray dosimeter, R. S. Caswell, Jan., 101
—relative biological effectiveness of fast neutrons in mice (ab), R. E. Carter et al, April, 634
—relative biological effectiveness of fast neutrons, x-rays, and γ -rays for acute lethality in mice (ab), A. C. Upton et al, Feb., 316
- NEVIASER, JULIUS S., and EISENBERG, SANFORD H.**: Diagnostic and therapeutic obstacles encountered in tibial plateau fractures (ab), April, 613
- NEVILLE, JOHN F., Jr.** See **FORD, WILLIAM B.**
- NEWBERY, G. R.** See **MORRISON, R.**
- NG, ELMER, and LOW-BEER, BERTRAM V. A.**: Treatment of Wilms' tumor (ab), April, 621
- NICE, CHARLES M., Jr.**: Relation of tumor size to radioresistance. April, 555
—See **GUNDERSEN, GUNNAR A.**
- MARGULIS, ALEXANDER R., and RIGLER, LEO G.**: A simple approach to the roentgen diagnosis of abdominal tumors in infants and children (ab), March, 459
- NICHAMIN, SAMUEL J.**: Kartagener's syndrome in a newborn infant (ab), May, 766
- NICHOLS, PHEROXY, Jr.** See **SMITH, GEORGE W.**
- NICOLAI, CHARLES H.**: Major reactions to intravenous urographic media (ab), June, 904
—Miokon, a new intravenous urographic medium (ab), Feb., 299
- NICOLAI, K. H.** See **HEITE, H.-J.**
- NIELSEN, O. STEINICKE, and ROELSGAARD, M.**: Roentgenologically demonstrable gastric abnormalities in cases of previous congenital pyloric stenosis (ab), Feb., 290
- NIMS, L. F., and GEISELSÖDER, J. L.**: Responses to whole-body x-irradiation in the starved rat (ab), May, 795
- NINHYDRIN-REACTIVE COMPOUNDS**. See Roentgen Rays, effects
- NOCARDIOSIS**
—case report and review of literature, Gunnar A. Gundersen and Charles M. Nice, Jr., Jan., 31
—pulmonary nocardiosis: review with report of 7 cases (ab), D. H. Webster, Feb., 285
- NOEL, R. D.** See **ADAMS, JOHN D.**
- NOGUÉS, ARMANDO E.** See **AHUMADA, JUAN C.**
- NOMOGRAMS**. See Radium, therapy
- NORDENSTRÖM, BJÖRN**. See **FIGLEY, MELVIN M.**
- NORMAN, OLOF**: Angiographic differentiation between acute and chronic subdural and extradural haematomas (ab), May, 756
- NORTH, JOHN P., LIVINGSTON, SHIELDS O., and LOVELL, B. K.**: Spontaneous renoduodenal fistula (ab), April, 609
- NOSE**
—clinical and radiological study of choanal polypi (ab), D. F. Reynolds and H. J. Groves, Feb., 279
—treatment of cancer of nasal cavity and paranasal sinuses (ab), James W. Hendrick, Jan., 143
- NOTTER, GUSTAF**: Management of malignant testicular tumors at the Radiumhemmet in Stockholm. Report on 247 patients (ab), April, 621
- NUCLEAR RADIATION**. See Protons
- NUCLEOGRAPHY**. See Spine, intervertebral disks
- NUSSBAUM, ARNOLD**. See **ROSENBLUM, DAVID**
- NYHAN, WILLIAM L., Jr.** See **GREEN, MORRIS**
- O**
- OBITUARIES**
Crosby, Leonard Green, May, 747

OBITUARIES—cont.

- Evans, William Albert, Feb., 271
 Graham, Everts A., May, 747
 Hinkel, L. Charles, Feb., 272
 Kirklín, Byrl Raymond, June, 876
 Pfahler, George Edward, April, 590
 Reuter, Frederic W., Jan., 113
- O'BRIEN, RICHARD G.** See WISE, ROBERT E.
- OBSTETRICS.** See Pelvis; Placenta; Pregnancy
- OLSHNER, SEYMOUR, and PENICK, RAWLEY M., Jr.:**
 Hemangioma of the small intestine, June, 845
- O'CONNOR, SYLVESTER J., and JACKNOW, ALBERT S.:**
 Posterior dislocation of the shoulder (ab), Feb., 297
- O'CONOR, VINCENT J.** See BULKLEY, GEORGE J.
- ODONTOID PROCESS.** See Atlas and Axis
- OESTER, Y. T.** See FIELDS, THEODORE
- OKAWA, CHIEKO, and TROMBKA, J. I.:** The technic of making microangiograms of rabbit bone marrow (ab), June, 907
- O'LEARY, DENIS J., and CURRY, FRANCIS J.:** Coccidioidomycosis. A review and presentation of 100 consecutively hospitalized patients (ab), Feb., 284
- OLSEN, NORMAN S.** See RUDOLPH, GUILFORD G.
- OLSON, B. WESLEY.** See BELL, ROBERT L.
- OLSON, KENNETH B.** See HALL, CHARLES A.
- O'NEIL, LAWRENCE J.** See LACOUR, EDWARD G.
- OPHTHALMOLOGY.** See Eyes; Orbit; etc.
- OPPENHEIMER, M. J., DURANT, T. M., STAUFFER, H. M., STEWART, G. H. III, LYNCH, P. R., and BARRERA, FRANK:** In vivo visualization of intracardiac structures with gaseous carbon dioxide. Cardiovascular-respiratory effects and associated changes in blood chemistry (ab), June, 893
- OPTIC CHIASM**
 —normal variations in position of optic recess of third ventricle (ab), James Bull, May, 753
- ORAVISTO, K. J., and SCHAUMAN, S.:** Urethrocystography in the differential diagnosis of prostatic cancer (ab), April, 615
- ORBIT**
 —congenital defect of bony orbit and pulsating exophthalmos (ab), Hooshang Tayebi and Frederic N. Silverman, June, 886
 —roentgen signs of space-occupying lesions of orbit (ab), L. Psenner, June, 885
- ORFOLD, THOMAS.** See MELTZER, HERBERT
- ORLOFF, MARSHALL J.:** Intussusception in children and adults. Collective review (ab), Feb., 293
- ORR, LOUIS M.** See THOMLEY, MILES W.
- ORTON, K. F.:** Rotation therapy with a 2 MeV Van de Graaff generator (ab), Feb., 307
- "OS SUBCLAVICULARE."** See Clavicle
- OSBORN, S. B., and SMITH, E. E.:** The genetically significant radiation dose from the diagnostic use of x-rays in England and Wales. A preliminary survey (ab), May, 793
- OSBORNE, G., PATTINSON, J. N., and WARD, M. W. P.:** Value of the lateral view of the rectosigmoid (ab), Feb., 293
- OSBORNE, J. C., and KOWALEWSKI, K.:** The uptake of radiolabeled sulfur in the fractured humerus in the rat (ab), May, 790
- OSBORNE, JAMES W.:** Prevention of intestinal radiation death by removal of the irradiated intestine (ab), April, 634
- OSHEROFF, H. R.:** Teaching aids for instruction in radiologic study of the gastrointestinal tract (ab), April, 610
- OSSIFICATION.** See Muscles
- OSTEITIS**
 See also Pubic Bone
- fibrosa**
 —adenoma of parathyroid gland associated with osteitis fibrosa cystica (ab), D. J. Reddy et al, May, 778
- OSTEOCHONDRITIS**
 —bilateral osteochondritis of middle cuneiform bone; case, Ivor P. Smyth, April, 575
 —osteochondritis ischiopubica (ab), Lars R. Holsti, Jan., 140
- deformans juvenilis**
 —coxa plana in dizygotic male twins (ab), Paul S. Derian, May, 783
- dissecans**
 —of ankle joint; case simulating fracture of talus (ab), Bruce M. Cameron, May, 794
- OSTEOCHONDROSES.** See Bones, abnormalities
- OSTEODYSTROPHY.** See Bones, atrophy
- OSTEOGENESIS IMPERFECTA.** See Bones, fragility
- OSTEOOMA.** See Tumors, osteoma
- OSTEOMYELITIS**
 See also Spine
 —acute hematogenous osteomyelitis (ab), Morris Green et al, Jan., 138
 —osteomyelitis and sarcoma (ab), F. De Witte, Jan., 139
- OSTEOPOROSIS.** See Bones, pathology
- OSTIUM PRIMUM.** See Heart, abnormalities
- OTTO PELVIS.** See Acetabulum
- OTTOLENGHI, ATHOS.** See BERNHEIM, FREDERICK
- OTTOMAN, R. E.** See WOODRUFF, J. H., Jr.
- OUTEIRO, FERNANDO.** See PINHEIRO, ARMANDO
- Ovary**
 —protection of ovaries from radiation (ab), Richard Batten and D. E. Meredith Brown, May, 791
- cancer**
 —experience with radioactive colloidal gold in treatment of carcinoma (ab), William C. Keettel and H. B. Elkins, Jan., 151
 —radioactive gold in treatment of carcinoma (ab), H. B. Elkins and William C. Keettel, April, 628
- tumors**
 —granulosa-cell tumor producing symptoms 4 years following radium menopause (ab), David M. W. Maxwell, Feb., 312
 —radiosensitivity of granulosa-cell tumor of ovary (ab), Basil A. Stoll, April, 620
- OVERBECK, L.** See SCHUBERT, G.
- OVUM.** See Embryo
- OWEN, CHARLES A., Jr.** See COOPER, MILTON
- See MCCONAHEY, WILLIAM M.
- OWEN, MORRIS:** A device for the localization of dental remnants in edentulous regions, April, 582
- OWEN, TREVOR, and LENCZNER, MICHAEL:** Generalized cysticercosis with cerebral infestation (ab), June, 884
- OXYGEN**
 —influence of x-ray on oxygen consumption of spleen and thymus glands of rats (ab), Maurice F. Sullivan and Kenneth P. DuBois, Feb., 314
- P**
- PACATAT HYDROCHLORIDE**
 —new drugs for irradiation sickness, Basil A. Stoll, March, 380
- PADOVAN, IVO, and PAVAO, FRANK:** Concerning the technic of irradiation with radioactive cobalt (ab), Jan., 151
- PALAMIDESSE, CARLO:** Middle lobe atelectasis of neuro-reflex origin (?) (ab), Jan., 126
- PALSY.** See Pharynx
- PANCREAS**
 —pancreatocystectomy combined with gastrectomy in cancer of stomach (ab), Komei Nakayama, June, 894
- cancer**
 —intravenous cholangiography as aid in diagnosis of carcinoma of head of pancreas, George Levene and Saul Scheff, May, 714
 —isotope implant therapy for internally situated tumors (ab), Paul V. Harper et al, May, 787
 —roentgenologic findings in stomach and duodenum in cancer of pancreas (ab), Kaare A. Larsen and Arne Pedersen, April, 608
- cysts**
 —unusual case of Lindau's disease: cystic disease of kidneys and pancreas with renal and cerebellar tumors (hemangioma) (ab), Frank Isaac et al, March, 460
- inflammation**
 —acute pancreatitis; preliminary investigation of new radiodiagnostic sign (ab), Charles Stuart, May, 773
 —cholangiographic diagnosis of pancreatitis (ab), Maurice D. Sachs and Philip F. Partington, June, 897
- PANCREATITIS.** See Pancreas
- PANTOMOGRAPHY.** See Body-Section Roentgenography
- PAPAGNI, LEONARDO:** Radiologic picture of intrathoracic tumors of the sympathetic nervous system (ab), March, 439
- PAPO, I.** See COLUMELLA, F.
- PARALYSIS.** See Paraplegia; Spine, curvature
- PARAPLEGIA**
 —bone, joint and soft-tissue changes following paraplegia (ab), Thomas Lodge, May, 780
 —paraplegia secondary to abdominal aortography (with use of Urokon) (ab), Joseph G. McCormack, April, 605
- PARASITES.** See Ascariasis; Poroccephalosis
- PARATHYROID**
 —radiological manifestations of hyperparathyroidism (ab), J. G. Duncan, March, 460
- cancer**
 —mediastinal parathyroid carcinoma with metastases; report of case and review of literature, Irving Weissman, James P. Worden and James M. Christie, March, 352
- tumors**
 —adenoma of parathyroid gland associated with osteitis fibrosa cystica (ab), D. J. Reddy et al, May, 778
 —nephrocalcinosis in patient with duodenal ulcer disease; case associated with parathyroid adenoma (ab), Robert E. Mitchell, Jr. et al, April, 615
- PARIETAL BONE.** See Cranium
- PARKER-PATERSON SYSTEM.** See Radium, therapy
- PARKHILL, URIE A.** See GIESELMAN, RALPH V.
- PAROTID GLANDS.** See Salivary Glands
- PARTINGTON, PHILIP F.** See SACHS, MAURICE D.
- PASSERINI, A.** See LOMBARDI, G.
- PASTOR, BERNARD H.** See HOLLENDONNER, WERNER J.
- PATERSON, D. E.:** Bone changes in leprosy (ab), March, 453
- PATERSON, EDITH.** See HAIGH, MARY V.
- PATERSON-PARKER SYSTEM.** See Radium, therapy
- PATRY, R., and GUEKDJIAN, S.:** Clinical and roentgen aspects of fracture cases (ab), March, 452
- PATTERSON, R. L., Jr.** See KING, P.
- PATTINSON, J. N.** See EMMANUEL, RICHARD W.
- See OSBORNE, G.
- See SMART, JOSEPH
- PAULSON, DONALD L.:** Importance of the pulmonary nodule (ab), Jan., 125
- PAULSON, E. C.:** Radioiodine uptake in the diagnosis of thyroiditis (ab), June, 912
- See ENGELS, EDWARD P.
- PAVAO, FRANK.** See PADOVAN, IVO

- PEABODY, J. WINTHROP, Jr.** See **DAVIS, EDGAR W.**
- PEACHER, WILLIAM G., and STORRS, RICHARD P.:** Roentgen diagnosis of herniated disk with particular reference to diskography (nucleography) (ab), June, 901
- PEARLMAN, ALEXANDER W.** See **FRIEDMAN, MILTON**
- PECTUS EXCAVATUM.** See **Thorax**
- PEDERSEN, ARNE.** See **LARSEN, KAARE A.**
- PEEBLES BROWN, D. A.** See **FORREST, A. P. M.**
- PEIFFER, J.** See **BREIT, A.**
- PELLISSIER, M.** See **BÉTOULIÈRES, P.**
- PELLIZARI, O.** See **REMOLAR, JORGE**
- PELVIMETRY.** See **Pelvis, measurement**
- PELVIS**
- See also **Uterus, cancer**
 - fracture of femoral neck following irradiation of pelvis (ab), Edgar L. Ralston, May, 790
 - mongolism (mongoloid deficiency) during early infancy—some newly recognized diagnostic changes in pelvic bones (ab), John Caffey and Steven Ross, March, 456
 - Otto pelvis; 2 cases associated with labor (ab), W. H. Muller, April, 614
 - pneumoperitoneum in diagnosis of pelvic disease (ab), Godfrey L. Gale and R. H. Giffin, Jan., 141
 - radiation injury to small bowel with special consideration of surgical complications (ab), H. Harvey Peterson and Edwin G. Clausen, May, 791
 - unusual cystic lesion of bone, limited to pelvis and lower extremities. Osteogenesis imperfecta cystica? Charles A. Bream and William H. Sprunt, III, Feb., 179
- blood supply**
- new radiologic methods in gynecology: aortography and pelvic arteriography (ab), L. Rossi and B. Maggipinto, Feb., 299
 - pelvic phlebography obtained by transosseous injection of contrast material (ab), A. Rabaioiti, Feb., 289
- measurement**
- new method of measurement of objects by x-rays with special reference to pelvimetry (ab), J. S. Colter, June, 906
- PENBERTON, JOHN:** Chronic bronchitis, emphysema, and bronchial spasm in bituminous coal workers. An epidemiologic study (ab), May, 763
- PENICK, RAWLEY M., Jr.** See **OCHSNER, SEYMOUR**
- PEPTIC ULCER**
- hepatic cirrhosis and gastro-duodenal ulcer (ab), E. de Arzuza Zulaica, Feb., 291
 - incidence of benign gastric ulcers on greater curvature: presentation of 3 cases (ab), John H. Feist and Jesse T. Littleton, March, 446
 - nephrocalcinosis in patient with duodenal ulcer disease: case associated with parathyroid adenoma (ab), Robert E. Mitchell, Jr. et al, April, 615
 - peptic ulcer, partial gastrectomy, and pulmonary tuberculosis (ab), P. A. Thorn et al, Jan., 124
 - postbulbar peptic ulceration of duodenum (ab), Robert F. Rauch, May, 773
 - tubeless gastric analysis in study of acid secretion following gastric irradiation for peptic ulcer (ab), John T. Galambos and Joseph B. Kirsner, Feb., 306
- cancer and peptic ulcer**
- x-ray manifestations of early malignant gastric ulceration (ab), G. A. S. Lloyd, March, 446
- perforation**
- duodenal loop changes in posterior penetration of duodenal ulcer (ab), J. George Teplick, March, 447
 - roentgenogram in perforated ulcer (ab), Lawrence S. Mann et al, Feb., 291
- PÉREZ-TAMAYO, RUHERI.** See **ETTINGER, ALICE**
- PERIARTERITIS NODOSA**
- circumscribed pulmonary lesions in periarteritis nodosa and Wegener's granulomatosis (ab), James V. Rogers, Jr. and Albert E. Roberto, May, 765
 - ulcerative jejunitis in polyarteritis, Alice Ettinger and Ruheri Perez-Tamayo, May, 609
- PERICARDITIS**
- pericardial effusion in generalized scleroderma (ab), Jay I. Meltzer, Feb., 287
- PERIFOLLICULITIS.** See **Scalp**
- PERIOSTEUM**
- juxtacortical chondroma (ab), Henry L. Jaffe, April, 610
 - rare bony and parosteal tumors in which radiotherapy is not indicated (ab), Willy Baensch, June, 909
- PERITONEUM**
- cancer**
- radioactive gold in malignant effusions (ab), Owen Millar and J. C. F. MacDonald, March, 470
 - radioyttrium (Y^{90}) for palliative treatment of effusions due to malignancy (ab), Elsie P. Siegel et al, April, 630
 - therapy of serous cavity effusion with colloidal radioactive gold 198 (ab), Edward P. Engels et al, June, 913
- effusions.** See **Peritoneum, cancer**
- tumors**
- treatment of peritoneal and pleural mesothelioma and metastatic malignancy with radioactive colloidal gold (ab), F. M. Lyle and Philip S. King, April, 628
- PERLBERG, HARRY J.** See **COHEN, SAMUEL**
- PERROT, Mma.** See **ROUSSEL, J.**
- PERRINGS, JAMES D.** See **ANDERSON, ERNEST C.**
- PERRY, H. C.** See **STRICKLAND, PAUL**
- PERRY, JOHN F., Jr., Vondrashek, Stanley C., and WANGENSTEEN, OWEN H.:** Recognition of strangulating intestinal obstructions with special reference to pneumoperitoneography (ab), April, 609
- PERUZZI, GASTONE, and RUFFATO, CESARE:** Radiology of aneurysms of the root of the superior mesenteric artery. Report of two cases (ab), March, 445
- PETERSON, H. HARVEY, and CLAUSEN, EDWIN G.:** Radiation injury to the small bowel with special consideration of surgical complications (ab), May, 791
- PETROVČIĆ, F.:** Presence of foam in the cerebrospinal fluid in encephalography (ab), Jan., 122
- PETTIT, HAROLD S.** See **ASHMORE, J. D.**
- PFAHLER, GEORGE EDWARD** (obit), April, 590
- PFEIFFER, J.:** Pharmacoradiography of the stomach (ab), Feb., 292
- PHALANGES.** See **Fingers and Toes**
- PHARMACORADIOGRAPHY.** See **Stomach, roentgenography**
- PHARYNX**
- cancer**
- indications for radical surgery, partial surgery, radiotherapy and combined surgery and radiotherapy for cancer of larynx and hypopharynx (ab), Jean Leroux-Robert, Jan., 144
- paralysis**
- radiologic investigation of pharyngeal and laryngeal palsy (ab), G. M. Ardian and F. H. Kemp, May, 761
- roentgenography**
- contrast examination of larynx and pharynx, William E. Powers, Harry H. McGee, Jr., and William B. Seaman, Feb., 169
 - radiology of pharyngo-esophageal region; Plummer-Vinson syndrome (ab), Victorino D'Alotto, Feb., 289
- PHÉLINE, CH., VIALLET, P., SENDRA, L., COMBE, P., CHEVROT, L., and AUBRY, P.:** Utilization of total simultaneous cerebral angiography by the intravenous route in the child (ab), May, 755
- PHEOCHROMOCYTOMA.** See **Tumors, pheochromocytoma**
- PHLEBOGRAPHY.** See **Brain, tumors; Pelvis, blood supply; Veins**
- PHOSPHAMIDASE.** See **Uterus, cancer**
- PHOSPHATASE**
- alkaline phosphatase activity in various mouse tissues following total-body x-irradiation (ab), Joseph L. Mollura and Anna Goldfeder, June, 917
- PHOSPHORUS.** See **Radioactivity, radiophosphorus**
- PHYSICIANS.** See **General Practice**
- PHYSICS**
- fellowships in radiological physics, May, 742
 - radiological physics fellowship, Sloan-Kettering Division, Cornell Medical College, March, 427
- PIAZZI, M.** See **SANTAGADA, A.**
- PICCHIO, CARLO.** See **CHIARIOTTI, FRANCO**
- PIETROLUONGO, ANTHONY L.** See **GARRITANO, ANTHONY P.**
- PINEAL GLAND**
- pinealoma with metastases in central nervous system. Rationale of treatment (ab), Fred D. Fowler et al, March, 462
- PINEALOMA.** See **Pineal Gland**
- PINHEIRO, ARMANDO, and OUTEIRO, FERNANDO:** A few cases of glandular-bronchial fistula (ab), Jan., 127
- PINTO, J. PORTUGAL.** See **GARDNER, W. JAMES**
- PIONNIER, R., and DEPRAZ, A.:** Congenital rib anomalies. Statistical study of 10,000 roentgenograms (ab), March, 455
- PIRKEY, EVERETT L., and UNDEM, DALE:** Intestinal obstruction from the radiological point of view (ab), April, 609
- PIRSON, HERBERT S.** See **CULVER, GORDON J.**
- PITUITARY BODY**
- pituitary radon implant for advanced cancer (ab), A. P. M. Forrest et al, March, 462
 - proton irradiation of pituitary and its metabolic effects; Memorial Fund lecture, Rollin K. McCombs, June, 797
- PLACENTA**
- gravitational placentography, K. E. Hodge, May, 637
 - radiological study of placental stage of labor (ab), John MacPherson and John K. Wilson, April, 614
 - soft tissue placentography in diagnosis of bicornuate uterus, Robert B. Engle, George Jacobson and Eleanor R. Fraser, March, 408
- PLEURA**
- pleuropulmonary tularemia: its roentgen manifestations, John M. Dennis and Robert P. Boudreau, Jan., 25
- cancer**
- radioactive gold in malignant effusions (ab), Owen Millar and J. C. F. MacDonald, March, 470
 - radioyttrium (Y^{90}) for palliative treatment of effusions due to malignancy (ab), Elsie P. Siegel et al, April, 630
 - therapy of serous cavity effusion with colloidal radioactive gold 198 (ab), Edward P. Engels et al, June, 913
- effusions.** See **Pleura, cancer**
- hematomas**
- roentgenologic aspects of retropleural hematomas following sympathectomy, Saul Scheff, Wallace W. Bednarz and George Levene, Feb., 224
- tumors**
- treatment of peritoneal and pleural mesothelioma and metastatic malignancy with radioactive colloidal gold (ab), F. M. Lyle and Philip S. King, April, 628
- PLUMMER-VINSON SYNDROME.** See **Deglutition, disorders**
- PNEUMATOSIS.** See **Colon, cysts**
- PNEUMOCYSTITIS.** See **Gallbladder, diseases**

PNEUMOCONIOSIS

- differential diagnosis between aluminum lung and Boeck's sarcoid; correction of article by K. H. Ehrecke (ab), F. Leicher, March, 438
- factors influencing radiological attack rate of progressive massive fibrosis (ab), A. L. Cochran and W. E. Miall, March, 438

PNEUMOCYSTIS. See Pneumonia**PNEUMOENCEPHALOGRAPHY.** See Brain; Meninges**PNEUMOGRAPHY**

- See also Brain, tumors; Pneumomediastinum; Pneumoperitoneum
- air embolism during presacral pneumography; case (ab), Irving Glassman et al, Jan., 143
- serious complications associated with newer diagnostic methods in urology (retroperitoneal pneumography and aortography) (ab), William Baurys, March, 459

PNEUMOMEDIASTINUM

- mediastinal pneumography (ab), Harold J. Isard et al, Feb., 285

PNEUMONIA

- See also Pneumonitis
- focal cartilizing necrotizing pneumonia and its differentiation from carcinoma of bronchus (ab), E. Zdansky, May, 763
- Pneumocystis carinii pneumonia in infant (ab), Georges Dautiez et al, June, 890
- temporary thrombotic state. Application of this concept to therapy of recurrent thrombo-embolism, with bacteriologic and roentgenologic considerations in the differential diagnosis of pulmonary infarction and pneumonia (ab), Stanford Wessler et al, Jan., 130

PNEUMONITIS

- interstitial pneumonitis in dermatomyositis (ab), Edward S. Mills and William H. Mathews, Feb., 284

PNEUMOPERITONEOGRAPHY. See Pneumoperitoneum**PNEUMOPERITONEUM**

- See also Pneumography
- in diagnosis of pelvic disease (ab), Godfrey L. Gale and R. H. Giffin, Jan., 141
- pneumostratigraphy in investigation of left lobe of liver (ab), P. Bétoulières et al, Feb., 293
- spontaneous pneumoperitoneum in newborn; case (ab), Arnold Porter, Feb., 293
- studies in recognition of strangulating intestinal obstructions with special reference to value of pneumoperitoneography (ab), John F. Perry, Jr. et al, April, 609
- unusual causes of free intraperitoneal air in acute conditions of the abdomen (ab), Robert D. Spensley et al, Jan., 131

PNEUMOTHORAX

- large pneumothorax and associated massive collapse of homolateral lung due to intrabronchial obstruction; case, Sidney W. Nelson, March, 411

POCHIN, E. E. See HILTON, GWEN

- POIRAU, A.**: Lesions of the bones of the leg in the course of varicose ulcers (ab), May, 783

POLLACK, ROBERT. See MACK, ROBERT E.**POLONIUM**

- RaD, RaE, and Po in atmosphere (ab), P. King et al, April, 636

POLYARTERITIS. See Periarteritis Nodosa**POLYMERIZATION.** See Roentgen Rays**POLYP.** See Tumors, polyp**POMPELLI, GIUSEPPE.** See BALZARINI, EMILIO

- PONTIUS, JOHN R., and JACOBS, LEWIS G.**: The reversal of advanced bronchiectasis, Feb., 204

- POPPEL, MAXWELL H., JACOBSON, HAROLD G., SHAPIRO, JEROME H., ADLER, HOWARD, and STEIN, JOSEPH**: Abnormal swallowing in central-nervous system and neuromuscular disease (ab), Jan., 123
- See JACOBSON, HAROLD G.
- See LENTINO, WALTER

- LENTINO, WALTER, ZAINO, COSTANTINO, and JACOBSON, HAROLD**: Closing mechanism of lower esophagus in man. Radiological study of five hundred unselected patients (ab), March, 445
- and ROBINSON, WILLIAM T.**: Roentgen manifestations of caisson disease (ab), May, 779

—See ZAINO, COSTANTINO**POROCEPHALOSIS**

- roentgen diagnosis of Armillifer infection in man, Howard L. Steinbach and Herbert G. Johnstone, Feb., 234

PORPHYRIA

- acute intermittent porphyria with acute abdominal findings and palpable mass (ab), Wesley Furste and Perry R. Ayres, Feb., 302

- PORSTMANN, W.**: Infectious spondylitis following damage to the anterior longitudinal ligament (contribution to the spondylitis following paravertebral anesthesia) (ab), May, 783

PORTAL VEIN

- diagnostic value of percutaneous splenoportography (ab), M. Róth and I. Jóna, April, 606
- does "laparoscopy" splenoportography indicate an advance in field of medical x-ray diagnosis? Contribution to early diagnosis of intrahepatic obstruction (ab), L. Wannagat, March, 451
- experimental study of intrahepatic distribution of portal blood (ab), Jack W. Cole et al, March, 468
- extrahepatic portal hypertension (portal vein thrombosis) diagnosed by percutaneous splenic venography (ab), Hector F. Rodriguez et al, April, 606

- splenoportography for diagnosis of portal hypertension (ab), José M. Falomir et al, May, 777

- splenoportography: valuable adjunct in study of portal hypertension (ab), Hector F. Rodriguez et al, May, 776

PORTER, ARNOLD: Spontaneous pneumoperitoneum in the newborn. Report of a case (ab), Feb., 293**PORTER, D. C.** See McCANN, J. SYDNEY**PORTER, EDWARD C.**: Measurement of the cervical spinal cord in Pantopaque myelography (ab), June, 902**PORTNOY, NELSON L.** See HOFFMAN, HOWARD A.

- POSER, CHARLES M., and TAVERAS, JUAN M.**: Cerebral angiography in encephalo-trigeminal angiomatosis, March, 327

POTASSIUM

- Los Alamos human counter (studies on potassium content of man) (ab), Ernest C. Anderson et al, March, 473
- radioactive. See Radioactivity, radiopotassium

POULOS, PETER. See KOVACH, JOHN C.

- POWELL, H. D. W.**: Interdigital sinuses in barber's hand (ab), Jan., 140

- POWERS, WILLIAM E., MCGEE, HARRY H., Jr., and SEAMAN, WILLIAM B.**: Contrast examination of the larynx and pharynx, Feb., 169

PREGNANCY

- See also Fetus; Pelvis, measurement
- carcinoma of cervix associated with pregnancy (ab), Glen E. Hayden, Feb., 304
- effect of antepartum diagnostic roentgenography on white blood cell count of newborn infant, Irwin H. Kaiser and James F. Marvin, Feb., 249

- PRICE, C. H. G.**: The grading of osteogenic sarcoma, and its bearing upon survival and prognosis (ab), Feb., 302

- PRIDGEN, JAMES E., and TENNISON, CHARLES W.**: Reconstruction of the entire anterior abdominal wall in the presence of postirradiation changes (ab), May, 792

PRINCIPATO, DOMINICK J. See LENTINO, WALTER**PRISONS AND PRISONERS.** See War**PRITCHARD, W. H.** See MOIR, T. W.**PROSTATE**

- position of patient for roentgenologic interpretation of prostatogram (ab), A. Estin Comarr, March, 459
- urethrocytographic classification of prostatism (ab), M. L. Brodny and S. A. Robins, March, 459
- vertebral osteomyelitis following operation on urinary tract or sigmoid; third lesion of uncommon syndrome (ab), Edwin L. Lame, March, 454

CANCER

- experiences with radioactive chromic phosphate in urological tumors (ab), Vincent Moore et al, Feb., 311
- present status of treatment of carcinoma of prostate with radioactive materials (ab), George J. Bulkley et al, March, 470
- recording of radioactivity in blood, liver, and prostate following interstitial administration of Au¹⁹⁸ in carcinoma of prostate (ab), Wayne M. Rounds and Titus C. Evans, April, 629
- treatment of inoperable carcinoma with radioactive gold (ab), Miles W. Thomley et al, April, 629
- urethrocytography in differential diagnosis of prostatic cancer (ab), K. J. Oravisto and S. Schaumann, April, 615

PROTEINS. See Blood, proteins; Cystine**PROTONS**

- isotopes and nuclear radiations (synchrocyclotron) in experimental medicine (ab), John H. Lawrence, April, 625

- proton irradiation of pituitary and its metabolic effects; Memorial Fund lecture, Rollin K. McCombs, June, 797

PRYDE, ARTHUR W. See SUTOW, WATARU W.

- PRYLES, CHARLES V.** See SHWACHMAN, HARRY
- PSENNER, L.**: Roentgen signs of space-occupying lesions of the orbit (ab), June, 885

PSEUDARTHROSIS

- fractures and pseudarthroses of first rib (ab), J. S. Dunbar, April, 612

PSORIASIS

- roentgen manifestations of psoriatic arthritis, Thomas F. Meaney and Robert A. Hays, March, 403

PUBIC BONE

- non-suppurative osteitis pubis in female (ab), Leon L. Wiltse and Charles H. Pratt, April, 613
- osteochondritis ischiopubica (ab), Lars R. Holsti, Jan., 140

PUBLIC HEALTH

- impact of atomic energy industry on community health; panel discussion (ab), May, 793
- public health traineeships, March, 427

- PUCK, THEODORE T., and MARCUS, PHILIP I.**: Action of x-rays on mammalian cells (ab), March, 475

PUGH, DAVID G. See ZIMMER, JAMES F.**PULMONARY VALVE**

- dilatation of pulmonary artery in pulmonary stenosis (ab), F. S. P. van Buchem, March, 442

PYELITIS. See Kidneys, cysts**PYELOGRAPHY**

- See also Hydronephrosis; Kidneys

- combined intravenous cholecystography and pyelography (with simultaneous administration of Biligrafin and Diodone) (ab), N. H. Aldridge, Jan., 143
- comparative study of value of sodium acetrizate (Diaglinol) 50 per cent and sodium diatrizoate (Hypaque) 45 per cent in intravenous urography (ab), B. Green and J. G. Sowerbutts, Jan., 142

PYELOGRAPHY—cont.

- effect of intravenous Benadryl in allaying allergic manifestations of 70 per cent Urokon (ab), Jack Lapides and Robert E. Boyd, April, 617
- excretory pyelography in infants: technique for intravenous injection (ab), Edward B. Singleton and Gunyon H. Harrison, March, 458
- excretory urography with Hypaque Sodium: experience with 300 cases (ab), Ernest Kraft and Gregory S. Slater, April, 617
- experiences with Triopac, new tri-iodine-containing contrast material, for intravenous urography (ab), J. Wellauer and M. Del Buono, May, 785
- heterotropic excretion of intravenously injected contrast media (Hypaque), Julian Arendt and Adam Zgoda, Feb., 238
- Hypaque in intravenous pyelography: analysis of 50 controlled examinations comparing Hypaque with 50 per cent Diodone (ab), Brian C. Hale, Jan., 142
- Hypaque Sodium, new urographic contrast medium (ab), Tom E. Nesbitt et al., June, 904
- intravenously given urographic mediums: comparative study of 800 cases (using Neo-Iopax, Urokon, Hypaque, and Renografin) (ab), Walter Lentino et al., April, 616
- iodide "mumps" after intravenous urography (ab), Ralph M. Sussman and Jay Miller, June, 905
- major reactions to intravenous urographic media (Urokon) (ab), Charles H. Nicolai, June, 904
- Miokon, new intravenous urographic medium (ab), Charles H. Nicolai, Feb., 299
- nephrography during routine excretory urography (ab), Arnold M. Wald, Jan., 142
- polycystic disease of kidney in infants: nephrograms following intravenous urography (ab), C. L. Hinkel and L. C. Santini, May, 784
- reactions due to intravenous Urokon (ab), Vernon H. Youngblood et al., April, 617
- report on 1028 cases of intravenous urography with sodium acetrizate (Diaginol) as contrast medium (ab), P. Cave et al., Jan., 142
- sodium amidotrizate (Hypaque) and sodium acetrizate (Urokon): comparison of efficacy in intravenous urography (ab), Malcolm D. Jones et al., June, 904
- urologic examination with new radiopaque mediums, diatrizate, acetrizate, and dipotrizate: clinical comparison (ab), Howard A. Hoffman et al., June, 904
- visualization of renal pelvis in cholangiography (ab), Georg Theander, Feb., 295

PYLORUS

- roentgenologically demonstrable gastric abnormalities in cases of previous congenital pyloric stenosis (ab), O. Steinicke Nielsen and M. Roelsgaard, Feb., 290

PYRIDOXIN HYDROCHLORIDE

- new drugs for irradiation sickness, Basil A. Stoll, March, 380

Q

- QUASTLER, HENRY:** The nature of intestinal radiation death (ab), March, 474

QUESTIONNAIRES

- on questionnaires and records (ed), Herbert L. Abrams, June, 869

- QUIMBY, EDITH H.:** Isotope studies of blood flow and blood cells (ab), April, 624

- QUINA, MARIO G.** See **FRANCO, VICTOR H.**

R

- RABAIOTTI, A.:** Pelvic phlebography obtained by transosseous injection of contrast material (ab), Feb., 289

- RABINOVITCH, JACOB, ANTON, JOSEPH I., RABINOVITCH, PHINEAS, and MITCHELL, NATHAN:** Primary carcinoma of the infrapapillary portion of the duodenum (ab), June, 896

- RABINOVITCH, PHINEAS.** See **RABINOVITCH, JACOB**

RADIATIONS

- See also Atomic Bomb and Atomic Energy; Betatron; Counters; Dosimeters and Dosimetry; Electrons; Neutrons; Polonium; Protons; Radioactivity; Radium; Roentgen Rays; Thorium

- flux of secondary ionizing particles in uniformly irradiated homogeneous medium of varying density: application to walled ionization chambers (ab), G. Failla, Feb., 309

- maximum permissible radiation exposures to man. Preliminary statement of National Committee on Radiation Protection and Measurement, Feb., 260; addendum to Radiation Handbook 60, June, 872

- photographic badges for estimation of quality of x and gamma radiation (ab), B. W. Soole, June, 916

- effects. See also Radiations, injurious effects

- correlation of early radiation changes in lymphatic tissues with antitoxin-producing ability (ab), William L. Williams et al., April, 636

- prompt effects of whole-body irradiation at high dose rate on electroencephalogram of monkeys (ab), Phillips M. Brooks, March, 475

- injurious effects. See also Radioactivity; Radium, injurious effects; Roentgen Rays, injurious effects; Thorium
- cancer of thyroid and irradiation (ab), Erich M. Uhlmann, April, 652

- experimental studies. See Radiations, effects

- fracture of femoral neck following irradiation of pelvis (ab), Edgar L. Ralston, May, 790

- hazards of radiation; Medical Research Council's report (ab), April, 632

- importance of intestinal flora in radiation treatment of gynecological carcinomata (ab), J. Breiter and W. Roth, April, 621

- nature of intestinal radiation death (ab), Henry Quastler, March, 474

- new drugs for irradiation sickness, Basil A. Stoll, March, 380

- professional radiation injuries in medical practice (ab), Hedi Fritz-Niggl, Jan., 153

- radiation as carcinogenic agent (ab), Austin M. Brues, Feb., 313

- radiation injury to small bowel with special consideration of surgical complications (ab), H. Harvey Peterson and Edwin C. Clausen, May, 791

- reconstruction of entire anterior abdominal wall in presence of postradiation changes (ab), James E. Pridgen and Charles W. Tension, May, 792

- skin replacement for severe radiation dermatitis of face (danger of recurrence) (ab), John J. Conley, March, 475

- surgical management of local postradiation effects (ab), J. J. Longacre, May, 792

- protection against. See also Roentgen Rays, protection against

- afterloading—contribution to protection problem (ab), Keith S. Mowatt and Keith A. Stevens, May, 787

- radiological defense plans in California (ab), Stafford L. Warren and Justin J. Stein, Feb., 312

RADIOACTIVITY

- See also Atomic Bomb and Atomic Energy; Polonium; Radiations; Radium; Thorium; Tritium

- automatic brain scanner for use with gamma-ray-emitting isotopes, W. B. Reid and H. E. Johns, Feb., 259

- calculation of maximum permissible concentrations for long-lived radioisotopes (ab), J. W. Healy, April, 626

- carcinogenesis by radioactive substances (ab), Jacob Furth and John L. Tullis, May, 791

- clinical aspects of treatment of carcinomas of gastrointestinal tract with isotopes (ab), Josef Becker and Kurt E. Scheer, June, 913

- course in the clinical use of radioactive isotopes, Jan., 109

- course in radiology and radioactive isotopes, University of Kansas, Jan., 109

- diagnostic tests that depend on radioisotope localization (ab), Marvin M. D. Williams and Donald S. Childs, Jr., April, 623

- in man and his environment (ab), F. W. Spiers, June, 914

- isotope implant therapy for internally situated tumors (ab), Paul V. Harper et al., May, 787

- isotopes and nuclear radiations (synchrocyclotron) in experimental medicine (ab), John H. Lawrence, April, 625

- medical care of wounds contaminated with radioactive materials (ab), Asher J. Finkel and Earl A. Hathaway, March, 476

- radioactive isotopes course, University of Southern California, March, 427

- radioisotopes course, Cook County Hospital, Chicago, March, 427

- some applications of isotope dilution techniques (ab), Rosalyn S. Yalow and Solomon A. Berson, April, 624

radioactinium

- analysis of mixtures of radioactive isotopes by γ -ray measurements. Application of method to Ac^{227} , Th^{227} , and Ra^{226} (ab), D. S. Anthony et al., March, 473

radiobarium

- elimination of radioactive barium sulfate particles from lung (ab), H. Cember et al., May, 796

radiocalcium

- artificial kidney and ion-exchange resins as possible methods of removing radioelements from body, W. B. Looney, C. J. Maletskos, Marie Helmick, John Reardon, Jonathan Cohen and Warren Guild, Feb., 255

radiocarbon

- autoradiographic study of organically bound carbon-14 in growing epiphyseal cartilage and bone (ab), Richard C. Greulich, April, 632

- biosynthesis of fatty acids in liver and intestine of intact normal, fasted and x-irradiated rats (using C^{14} -acetate) (ab), John G. Coniglio et al., April, 635

- rate of elimination of labeled carbon dioxide from body (ab), Douglas R. Drury et al., June, 914

radiocesium

- analysis of Cs^{137} content in man due to radioactive fallout, C. E. Miller, L. D. Marinelli and O. J. Steingraber, Jan., 105

radiochromium. See also Radioactivity, radiophosphorus

- blood volume changes in cases of cerebral trauma as determined by radioactive isotopes (ab), Edmund A. Smolik et al., Jan., 152

- blood volume determinations with radioactive chromium (Cr^{51}) labeled erythrocytes: feasibility of routine total red blood cell volume determinations in general hospital (ab), Leo M. Meyer, Feb., 311

- determination of cell volume in massive transfusions using Fe^{59} and Cr^{51} (ab), E. L. Smith et al., May, 790

- labeling human erythrocytes with radiochromium (ab), Milton Cooper and Charles A. Owen, Jr., March, 472

radiocobalt

- aftercare following intraluminal cobalt therapy for carcinoma of bladder (ab), Robert E. Schick, Feb., 312

RADIOACTIVITY, radiocobalt—cont.

- comparative mortality following single whole-body exposures of mice to fission neutrons and Co^{60} gamma rays, Howard H. Vogel, Jr., John W. Clark and Donn L. Jordan, March, 386
 - concerning technic of irradiation (ab), Ivo Padovan and Pavao Frank, Jan., 151
 - conditioned responses to manipulative procedures resulting from exposure to gamma radiation (ab), John Garcia et al, May, 795
 - dosage calculations for rotation therapy, with special reference to cobalt 60 (ab), H. E. Johns et al, April, 631
 - dosage distribution in rotational cobalt 60 therapy (ab), D. E. A. Jones et al, Feb., 308
 - evaluation of fecal recovery method for determining intestinal absorption of cobalt⁶⁰-labeled vitamin B₁₂ (ab), James A. Halsted et al, May, 790
 - neutron-insensitive gamma-ray dosimeter, R. S. Caswell, Jan., 101
 - new telegraph apparatus (for use with radioactive cobalt) (ab), Bo Lindell and Rune Walstam, Jan., 151
 - plasma, tissue and urinary radioactivity after oral administration of ^{60}Co -labeled vitamin B₁₂ (ab), C. C. Booth and D. L. Mollin, May, 789
 - relative biological effectiveness of fast neutrons, x-rays, and γ -rays for acute lethality in mice (ab), A. C. Upton et al, Feb., 316
 - studies in urinary excretion of vitamin B₁₂ Co^{60} in pernicious anemia for determining effective dosage of intrinsic factor concentrates (ar), William R. Best et al, March, 471
 - time pattern of vitamin B₁₂ Co^{60} urinary excretion in man after oral administration and parenteral "flushing" (ab), William R. Best et al, March, 472
- radiocopper**
- studies on copper metabolism. XXI. Transfer of radiocopper between erythrocytes and plasma (ab), J. A. Bush et al, March, 472
- radiogallium**
- localization of Ga^{72} in bone lesions (ab), H. C. Dudley et al, April, 631
- radioglycine**
- incorporation of N^{15} -labeled glycine in plasma protein, plasma phospholipids, blood non-protein nitrogen, and splenic tissue in man (ab), D. S. Amatozio et al, March, 472
- radiogold**
- acute radiation death of dogs receiving single massive dose of intravenous radioactive gold (ab), P. F. Hahn et al, April, 629
 - aplastic anemia secondary to intravenous therapy; case (ab), Harold M. Schoolman and Steven O. Schwartz, Jan., 152
 - disseminated histiocytosis X (Letterer-Siwe's disease) treated unsuccessfully with colloidal gold (Au^{198}); case (ab), Theodore A. Tristan et al, June, 913
 - dosimetry of interstitial implants, M. L. Meurk, A. Jacobson and R. J. Schultz, Feb., 256
 - experience with colloidal gold in treatment of ovarian carcinoma (ab), William C. Keetzel and H. B. Elkins, Jan., 151
 - histopathological study of lymph nodes irradiated with colloidal Au^{198} (ab), William M. Christopherson and Harold F. Berg, Feb., 311
 - in malignant effusions (ab), Owen Millar and J. C. F. MacDonald, March, 470
 - in treatment of ovarian carcinoma (ab), H. B. Elkins and William C. Keetzel, April, 628
 - lymphatic dissemination of radiogold in presence of lymph node metastases (ab), Colin G. Thomas, Jr., May, 788
 - present status of treatment of carcinoma of prostate with radioactive materials (ab), George J. Bulkley et al, March, 470
 - recording of radioactivity in blood, liver, and prostate following interstitial administration of Au^{198} in carcinoma of prostate (ab), Wayne M. Rounds and Titus C. Evans, April, 629
 - study of lymphatics of mammary gland with Au^{198} (ab), Felix E. Leborjane et al, March, 470
 - study of methods for implantation of radioactive materials (ab), H. C. Dudley and T. G. Mitchell, April, 625
 - technic for permanent implantation of radioisotopes, Ulrich K. Henschke, Feb., 256
 - therapy of serous cavity effusion with colloidal radioactive gold 198 (ab), Edward P. Engels et al, June, 913
 - treatment of inoperable prostatic carcinoma (ab), Miles W. Thomley et al, April, 629
 - treatment of peritoneal and pleural mesothelioma and metastatic malignancy with colloidal gold (ab), F. M. Lyle and Philip S. King, April, 628
- radioiodine. See also Thyroid**
- blood volume changes in cases of cerebral trauma as determined by radioactive isotopes (ab), Edmund A. Smolik et al, Jan., 152
 - clearance from lower extremities of patients with myocardial infarction (ab), Franz K. Bauer et al, May, 788
 - clinical study of new renal function test: radioactive Diodrast renogram (ab), Chester C. Winter, June, 903
 - determination of protein-bound I^{131} with anion exchange resin column (ab), Theodore Fields et al, March, 469
 - determination of protein-bound radioiodine with an anion exchange resin (ab), Leslie Zieve et al, March, 469

- disulfide reduction and release of iodide 131 following irradiation of I^{131} labeled proteins, Rosalyn S. Yalow and Solomon A. Berson, Jan., 100
 - early disappearance of I^{131} serum albumin from circulation of edematous subjects and its implications in clinical determination of blood volume (ab), T. W. Moir et al, March, 469
 - evaluation of peripheral arteriosclerotic insufficiency utilizing radioactive iodinated human serum albumin (ab), Earl J. Halligan et al, March, 468
 - investigation of transfer rates of albumin tagged with I^{131} in ascites and edema. II. Studies in control subjects and patients with cirrhosis (ab), James A. Schoenberger et al, March, 469
 - in vivo method for determination of cardiac output (by use of externally positioned scintillation counter and radioiodinated human serum albumin as trace material), Robert E. Mack, Herschel J. Wells and Robert Pollack, Feb., 245
 - iodine-131 beta particle dosage in small animals, Patricia W. Durbin, James S. Robertson and Joseph G. Hamilton, Jan., 103
 - radioiodine course, Georgetown University, March, 426
 - rate of intravascular equilibration of intravenously administered I^{131} -labeled albumin in various body sites (ab), Arthur Bauman and Marcus A. Rothschild, May, 789
 - scintiscanning as method for localization of cerebral tumors (ab), Robert L. Bell et al, May, 758
- radioiridium**
- dosimetry of interstitial implants, M. L. Meurk, A. Jacobson and R. J. Schultz, Feb., 256
 - technic for permanent implantation of radioisotopes, Ulrich K. Henschke, Feb., 256
- radioiron**
- determination of cell volume in massive transfusions using Fe^{59} and Cr^{51} (ab), E. L. Smith et al, May, 790
 - in routine hematological practice (ab), G. Wetherley-Mein et al, April, 631
 - isotope studies of blood flow and blood cells (ab), Edith H. Quimby, April, 624
- radiophosphorus**
- diagnostic significance of radioactive isotopes in early cancer of alimentary tract, especially esophagus and cardia (ab), Komei Nakayama, April, 630
 - effect of radiophosphorus and cortisone on transplanted mammary adenocarcinomas in susceptible and resistant mice (ab), Norman E. Boucher, Jr., et al, May, 789
 - experiences with radioactive chromic phosphate in urological tumors (ab), Vincent Moore et al, Feb., 311
 - influence of temperature stress on uptake of P^{32} in rat (ab), John A. Sealander, Jr., June, 918
 - present status of treatment of carcinoma of prostate with radioactive materials (ab), George J. Bulkley et al, March, 470
 - sex difference in response to titrated irradiation therapy (^{32}P) of patients with chronic granulocytic leukemia (ab), William H. Crosby et al, May, 788
 - small end-window and angle-window Geiger counters; measurement of radioactivity in intra-ocular tumors following injection of radioactive phosphorus (ab), Charles I. Thomas et al, April, 630
 - study of methods for implantation of radioactive materials (ab), H. C. Dudley and T. G. Mitchell, April, 625
 - subdural collections of fluids in infants and children. II. Study with radioactive sodium phosphate (P^{32}) (ab), R. M. N. Crosby and Robert E. Bauer, Jan., 121
 - surgical and radiation treatment of carcinoma of breast; new concept (ab), Bertram V. A. Low-Beer and H. Glenn Bell, April, 619
 - transilluminator for use with curved Geiger counter; aid to localization of posterior intra-ocular tumors (ab), Charles I. Thomas and Jack S. Krohmer, April, 630
- radiopotassium**
- comparison of metabolism of rubidium 86 and potassium 42 following simultaneous injection into man (ab), Malcolm P. Tyor and James S. Eldridge, June, 913
 - transfer of potassium between blood, cerebrospinal fluid and brain tissue (ab), Guilford G. Rudolph and Norman S. Olsen, May, 789
- radiorubidium**
- comparison of metabolism of rubidium 86 and potassium 42 following simultaneous injection into man (ab), Malcolm P. Tyor and James S. Eldridge, June, 913
- radiosodium**
- isotope studies of blood flow and blood cells (studied by radiocardiography) (ab), Edith H. Quimby, April, 624
- radiostrontium**
- artificial kidney and ion-exchange resins as possible methods of removing radioelements from body, W. B. Looney, C. J. Maletskos, Marie Helmeick, John Reardon, Jonathan Cohen and Warren Guild, Feb., 255
 - clinical experiences with strontium 90 applicator (ab), Eugene F. Lutterbeck and Irvin F. Hummon, Jr., Jan., 152
 - investigation into experimental production of cancer by local beta irradiation (ab), G. Schubert et al, May, 794
 - treatment of hemangiomas with strontium-90 beta-ray applicator, David M. Sklaroff, Jan., 87
- radiothulium**
- uptake of radiothulium in fractured humerus in rat (ab), J. C. Osborne and K. Kowalewski, May, 790

RADIOACTIVITY—cont.

- radioyttrium
 - effect of peritoneal tissue infiltration with radioactive yttrium on growth and spread of malignant cells (ab), Horace Goldie and Harold D. West, May, 790
 - present status of treatment of carcinoma of prostate with radioactive materials (ab), George J. Bulkley et al, March, 470
 - study of methods for interstitial implantation of radioactive materials (ab), H. C. Dudley and T. G. Mitchell, April, 625
 - Y⁹⁰ for palliative treatment of effusions due to malignancy (ab), Elsie P. Siegel et al, April, 630

RADIOCARDIOGRAPHY. See Heart**RADIOISOTOPES.** See Radioactivity**RADIOLOGICAL SOCIETIES**

- Arizona Radiological Society, Feb., 269
- Association of Radiologists of the Province of Quebec, March, 426
- Biophysical Society, May, 742
- Canadian Association of Radiologists, May, 742
- Colorado Radiological Society, Jan., 108; April, 586
- Eastern Conference of Radiologists, Jan., 108
- Greater Miami Radiological Society, March, 426
- Greater Saint Louis Society of Radiologists, March, 426
- Houston (Texas) Radiological Society, Feb., 269
- Kansas Radiological Society, May, 742
- Kentucky Radiological Society, May, 742
- Miami Valley (Ohio) Radiological Society, Feb., 269
- Mississippi Radiological Society, April, 586
- Nassau (N.Y.) Radiological Society, Jan., 108
- New York Roentgen Society, June, 872
- Philadelphia Roentgen Ray Society, June, 872
- Radiation Research Society, March, 426
- Radiological Society of Greater Cincinnati, Jan., 108
- Rochester Roentgen Ray Society, March, 426
- Rocky Mountain Radiological Society, March, 426
- secretaries and meeting dates, Jan., 114; April, 593
- Sociedad de Radiología, Cancerología y Física Médica del Uruguay, May, 742
- Sociedad Mexicana de Radiología, April, 586
- Society of Nuclear Medicine, June, 872
- Tennessee Radiological Society, June, 872
- Wisconsin Radiological Society, Jan., 109

RADIOLOGICAL SOCIETY OF NORTH AMERICA

- Virden, C. Edgar, president (ed), Ira H. Lockwood, Feb., 262
- forty-second annual meeting
 - (ed), Feb., 264
 - Carman lecture: Science and solitude vs. clinical consultation, Lowell S. Goin, March, 319
 - introduction of Carman lecturer, Clarence E. Hufford, March, 317
 - Memorial Fund lecture: proton irradiation of pituitary and its metabolic effects, Rollin K. McCombs, June, 797
 - presidential address: Attitudes in radiology (ed), Clarence E. Hufford, March, 423
 - refresher courses, Feb., 268
 - scientific exhibits, Feb., 266
- gold medal
 - presentation to Dr. Lawrence Reynolds, Feb., 264

RADIOLOGY AND RADIOLOGISTS

- attitudes in radiology: Presidential address: Radiological Society of North America (ed), Clarence E. Hufford, March, 423
- Fourth Congress of Radiology and Electrolgy of Latin Culture, Jan., 109
- professional radiation injuries in medical practice (ab), Hedi Fritz-Niggli, Jan., 153
- teaching of chest radiology to medical students (ab), Charles T. Dotter, April, 603

RADIOMANOMETRY. See Biliary Tract, roentgenography**RADIOTHERAPY**

- See also Cancer, radiotherapy; Dosimeters and Dosimetry; Electrons; Ionization Chambers; Protons; Radiations, injurious effects; Radiations, protection against; Radium; Roentgen Therapy; under diseases, organs, and regions
- basic aspects of radiation therapy (ab), W. S. Moos, April, 622

RADIUM

- See also Radiations; Radiotherapy; Radon; etc.
- analyses of mixtures of radioactive isotopes by γ -ray measurements. Application of method to Ac²²⁷, Th²³², and Ra²²⁶ (ab), D. S. Anthony et al, March, 473
- injurious effects
 - granulosa-cell tumor producing symptoms 4 years following radium menopause (ab), David M. W. Maxwell, Feb., 312
 - RaD, RaE, and Po in atmosphere (ab), P. King et al, April, 636
- protection against
 - new radium implant technic to reduce operating room exposure and increase accuracy of placement (ab), Robert Fishman and Lester I. Citrin, Jan., 150
- therapy. See also under diseases, organs, and regions, as Uterus, cancer
 - application of Paterson-Parker system in interstitial radium therapy (ab), Fernando G. Bloedorn, Jan., 149
 - graphical method for localization of radium sources for dosage calculation (ab), Morton M. Kligerman et al, Jan., 149

- nomographic wheel for three dimensional localization of radium sources and calculation of dose rate (ab), J. Garrett Holt, Jan., 150

RADON, H. See AURIG, G.**RADON**

- See also Pituitary Body
- dose to trachea and bronchi from decay products of radon and thoron (ab), A. C. Chamberlain and E. D. Dyson, April, 633
- dosimetry of interstitial implants, M. L. Meurk, A. Jacobson and R. J. Schultz, Feb., 256
- retention of radon decay products in human lungs (ab), Čestmír Jech, May, 793
- stable, low-background, high-efficiency scintillation counter for analysis of low levels of radon concentrated by adsorption on charcoal, H. F. Lucas, Jr., Feb., 258
- technic for permanent implantation of radioisotopes, Ulrich K. Henschke, Feb., 256

RALL, J. E.: Role of radioactive iodine in the diagnosis of thyroid disease (ab), March, 466**RALSTON, EDGAR L.:** Fracture of the femoral neck following irradiation of the pelvis (ab), May, 790**RAMSAY, GORDON S.:** The negative x-ray report in cancer of the colon (ab), March, 448**—See HAJDU, N.****RAMSEY, GEORGE H.** See CORNWELL, WILLIAM S.**RANDALL, JOHN H., and GODDARD, WILLIAM B.:** A study of 531 cases of endometrial carcinoma (ab), June, 909**RANKIN, J. A.** See CAVE, P.**RAO, T. SURYAPRAKASA.** See REDDY, D. J.**RAPHAEL, ROBERT L.** See JONES, MALCOLM D.**RATELLE, GERMAINE, and LÉGER, JEAN-LOUIS:** Roentgen findings in genital tuberculosis in women (ab), Jan., 140**RATLIFF, A. H. C.:** Tuberculosis at the site of spondylolisthesis (ab), Jan., 139**RATTNER, HERBERT, CHAMBERLAIN, W. EDWARD, et al:** X-rays in dermatology (ab), May, 792**RAUCH, ROBERT F.:** Postbulbar peptic ulceration of the duodenum (ab), May, 773**RAVENTOS, ANTONIO.** See TRISTAN, THEODORE A.**RAVITCH, MARK M.** See WACHTEL, FRED W.**—See WILDER, ROBERT J.****RAWSON, S. P.:** Some rare causes of vomiting in infancy and childhood (ab), March, 460**REARDON, JOHN.** See LOONEY, W. B.**RECORDS**

- on questionnaires and records (ed), Herbert L. Abrams, June, 869

RECTUM

- dose decrease in bladder and rectum in gynecologic radium treatments (ab), August Verhagen, Jan., 146
- radiation combined with surgery in treatment of rectal neoplasms in various stages (ab), P. Gambaccini, Jan., 145
- significance of ureteral studies in surgery of colon and rectum (ab), H. E. Bacon and L. McCrea, March, 458
- value of lateral view of rectosigmoid (ab), G. Osborne et al, Feb., 293

REDDY, D. BHASKARA. See REDDY, D. J.**REDDY, D. J., RAO, T. SURYAPRAKASA, GUPTA, K. GOPALAKRISHNIAH, DEVI, SAKUNTALA, MUNISWAMY, M., and REDDY, D. BHASKARA:** Adenoma of the parathyroid gland associated with osteitis fibrosa cystica (ab), May, 778**REED, C. E.:** A study of the effects on the lung of industrial exposure to zirconium dusts (ab), May, 761**REICH, NATHANIEL E., and EHRLICH, DAVID E.:** Displacements of the barium-filled esophagus by cardiovascular lesions (ab), Feb., 286**REICH, RUDOLPH.** See ROSENBERG, NORMAN**REICH, STANLEY B., FELTON, LELAND R., and LEVITIN, JOSEPH:** Cholangiography after cholecystectomy. Visualization with Cholografin by vein (ab), March, 450**REID, CYPRIAN B.** See ROSWIT, BERNARD**REID, W. B., and JOHNS, H. E.:** An automatic brain scanner for use with gamma-ray-emitting isotopes, Feb., 259**REINER, LEOPOLD.** See FRANK, HOWARD A.**REIQUAM, C. W., BEATTY, E. C., Jr., and ALLEN, R. P.:** Neuroblastomas in infancy and childhood. Review of ten years' experience (ab), April, 621**REMOLAR, JORGE, KATZ, S., RYBAK, B., and PELLIZARI, O.:** Percutaneous transhepatic cholangiography (ab), May, 775**RENFER, HANSRUDOLPH:** Treatment of skin tumors of the inner canthus with regard to the function of the lacrimal ducts (ab), Jan., 143**—See NEUENSCHWANDER, H.****RENOGRAFIN.** See Pyelography**RENOVANZ, H.-D.:** The tuberculous coin lesion—a roentgenological symptom. (Observations in children and adolescents) (ab), March, 438**RESINS**

- artificial kidney and ion exchange resins as possible methods of removing radioelements from the body, W. B. Looney, C. J. Maletskos, Marie Helmick, John Reardon, Jonathan Cohen and Warren Guild, Feb., 255
- determination of protein-bound I¹³¹ with anion exchange resin column (ab), Theodore Fields et al, March, 469
- determination of protein-bound radioiodine with an anion exchange resin (ab), Leslie Zieve et al, March, 469

RESPIRATION

- elimination of radioactive barium sulfate particles from lung (ab), H. Cember et al, May, 796
- pendular motion of mediastinum (ab), Philip Samet and William Anderson, April, 602
- roentgenographic findings in respiratory problems of infants (ab), S. B. Feinberg, March, 439

RESPIRATORY TRACT

- See also Bronchi; Lungs; Pharynx; etc.
- in vivo visualization of intracardiac structures with gaseous carbon dioxide; cardiovascular-respiratory effects and associated changes in blood chemistry (ab), M. J. Oppenheimer et al, June, 893
- some anomalies of respiratory system (ab), S. Whately Davidson, May, 762

RETICULOENDOTHELIAL SYSTEM

- See also Bones, marrow; Liver; Spleen
- disseminated histiocytosis X (Letterer-Siwe's disease) treated unsuccessfully with radioactive colloidal gold (Au¹⁹⁹); case (ab), Theodore A. Tristan et al, June, 913

RETICULOSARCOMA. See Sarcoma, reticulosarcoma**RETROPERITONEUM**. See Abdomen; Pneumography**REUTER, FREDERIC W.** (obit), Jan., 113**REYNOLDS, D. F., and GROVES, H. J.**: Clinical and radiological study of choanal polyp (ab), Feb., 279**REYNOLDS, LAWRENCE**, awarded Gold Medal of Radiological Society of North America, Feb., 264**RHEUMATISM**. See Arthritis, Rheumatoid**RIBS**

- congenital rib anomalies; statistical study of 10,000 roentgenograms (ab), R. Pionnier and A. Depraz (ab), March, 455
- fractures and pseudarthroses of first rib (ab), J. S. Dunbar, April, 612

RICHER, E. W.: Radiotherapy in renal new growths (ab), May, 786**RICH-HAMMAN SYNDROME**. See Lungs, fibrosis**RIEMENSCHNEIDER, PAUL A.**: Trigonoccephaly, June, 863**RIGLER, LEO G.**. See AMBERG, JOHN R.

—See NICE, CHARLES M., Jr.

RILEY, CONRAD M.. See KIRKPATRICK, ROB H.**RINGERTZ, N., and LIDHOLM, S. O.**: Mediastinal tumors and cysts (ab), Feb., 286**RITTER, A., and HELMIG, H.**: Experiences with diagnostic angiocholangiography and "peroperative radiomanometry" in cholelithiasis (ab), March, 450**ROAF, ROBERT**: Paralytic scoliosis (ab), June, 899**ROB, C. G.**. See EASTCOTT, H. H. G.**ROBAJDEK, E. S.**. See ANTHONY, D. S.**ROBBINS, KENNETH C.**. See BEST, WILLIAM R.**ROBBINS, LAURENCE L.**. See WANG, C. C.**ROBERTO, ALBERT E.**. See ROGERS, JAMES V., Jr.**ROBERTS, JAMES C., Jr., and CARLSON, KENNETH E.**: Hepatic duct carcinoma seventeen years after injection of thorium dioxide (ab), May, 791**ROBERTS, S. M.**. See WALLER, ROBERT D.**ROBERTSON, E. GRAEME**. See EBELING, P.**ROBERTSON, J. S., and HUGHES, W. L.**: Theoretic considerations of the radiation dose from discrete tritium sources, Jan., 102

—See BOND, V. P.

—See DURBIN, PATRICIA W.

ROBINS, S. A.. See BRODNY, M. L.**ROBINSON, C. V.**. See SELVERSTONE, B.**ROBINSON, FRANKLIN**. See GLASSMAN, IRVING**ROBINSON, LEWIS S.**. See CRAWFORD, EDWARD J., Jr.**ROBINSON, WILLIAM T.**. See POPPEL, MAXWELL H.**ROBY, H. R., and McKAY, J. W.**: Fatality following abdominal arteriography (ab), Jan., 131**ROCKWOOD, LAWRENCE**. See CLARKE, B. G.**RODRIGUEZ, HECTOR F., DIAZ BONNET, RAFAEL, and RODRIGUEZ-PEREZ, DAVID**: Extrahepatic portal hypertension (portal vein thrombosis) diagnosed by percutaneous splenic venography (ab), April, 606

—GARDNER, FRANK H., and DIAZ-BONNET, RAFAEL: Splenoportography: a valuable adjunct in the study of portal hypertension (ab), May, 776

RODRIGUEZ-PEREZ, DAVID. See RODRIGUEZ, HECTOR F.**ROELSJAARD, M.**. See NIELSEN, O. STEINICKE**ROENTGEN RAYS**

See also Betatron; Body-Section Roentgenography; Cineradiography; Radiations; Radiotherapy; Roentgen Therapy; etc.

—biliary tract studies. I. X-ray diffraction analysis of gallstones; correlation with occurrence of microspheruliths in bile (ab), Kerrison Juniper, Jr., and William E. Woolf, Jan., 134

—radiation polymerization of liquids, Frank E. Hoecker and Ivan Watkins, Feb., 257

apparatus. See also Counters; Roentgen Rays, fluoroscopy; Roentgen Therapy

—cerebral serial angiography (Skull Odela camera) on 70 mm. film (ab), Heinz Vieten, June, 882

—device for localization of dental remnants in edentulous regions, Morris Owen, April, 582

—improved syringe for angiography (ab), B. Selverstone et al, March, 461

diagnosis. See also Roentgen Rays, apparatus; Roentgen Rays, injurious effects; Roentgen Rays, protection against; under diseases, organs, and regions

—summation image in diagnostic roentgenology (ab), Joseph Duhamel and Daniel Herpe, March, 461

—television in diagnostic roentgenology (ab), R. Janker, Feb., 301

dosimetry. See Dosimeters and Dosimetry; Roentgen Therapy**effects**. See also Roentgen Rays, injurious effects

—action of x-rays on mammalian cells (ab), Theodore T. Puck and Philip I. Marcus, March, 475

—alkaline phosphatase activity in various mouse tissues following total-body x-irradiation (ab), Joseph L. Mollura and Anna Goldfeder, June, 917

—analysis of effects of total-body x-irradiation on body weight of white Swiss mice. II. Bodyweight changes of male mice as biological dosimeter (ab), William H. Chapman and Edward A. Jerome, April, 633

—animal experiments on radiosensitivity of growing bone (ab), Pierre van Cananeghem and Carl G. Schirren, May, 796

—biosynthesis of fatty acids in liver and intestine of intact normal, fasted and x-irradiated rats (ab), John G. Coniglio et al, April, 635

—comparative activity of isologous vs. homologous or heterologous mouse bone marrow in promoting regeneration of irradiated mouse thymus (ab), Barbara B. Hirsch et al, May, 795

—comparative effectiveness of several x-ray qualities for acute lethality in mice and rabbits (ab), Douglas Grahn et al, March, 474

—comparison of biological effects of whole-body irradiation with 22.5 MEV x-rays, 18-MEV electrons, and 400-kev x-rays in rat (ab), John B. Fuller et al, Feb., 315

—dependence of latency period of radiobiologic reaction on size of dose (ab), Felix Wachsmann and Apostolos Yiannakopoulos, May, 793

—direct and indirect effects of x-rays on testis of rat (ab), Henry I. Kohn, Feb., 314

—disulfide reduction and release of iodide 131 following irradiation (with x-rays) of ¹³¹I labeled proteins, Rosalyn S. Yalow and Solomon A. Berson, Jan., 100

—early changes of bone of adult guinea-pigs after irradiation (ab), Rudolph Birkner et al, June, 917

—early vasoconstriction induced in isolated rabbit's ear by radiation (ab), Phillips M. Brooks et al, April, 635

—effect of total-body irradiation on plasma volume, red cell volume, blood volume and thiocyanate space in normal and splenectomized rats (ab), Kee-Chang Huang and James H. Bondurant, April, 635

—effect of transfusions of blood showing extreme leukocytosis on survival of x-irradiated mice (ab), C. C. Congdon et al, April, 634

—effects of acute irradiation on evoked cerebellar response (ab), John C. Lee et al, Feb., 315

—effects of hydration on x-ray sensitivity in Hordeum (ab), Richard S. Caldecott, March, 475

—effects of single session of whole-body irradiation in Rhesus monkey (ab), Mary V. Haigh and Edith Paterson, Jan., 154

—efficacy of hematopoietic protective procedures in rats irradiated with intestine shielded (ab), Marguerite N. Swift et al, March, 474

—enlargement of liver in Sprague-Dawley rats following whole-body irradiation (ab), Helen Supplee et al, April, 635

—incidence of endogenous bacteremia in irradiated rabbits (ab), Carolyn W. Hammond and C. Phillip Miller, Feb., 315

—indirect induction of lymphomas in irradiated mice. I. Tumor incidence and morphology in mice bearing non-irradiated thymic grafts (ab), Henry S. Kaplan et al, May, 794

—indirect induction of lymphomas in irradiated mice. II. Factor of irradiation of host (ab), Henry S. Kaplan et al, May, 794

—indirect induction of lymphomas in irradiated mice. III. Role of thymic graft (ab), William H. Carnes et al, May, 794

—indirect induction of lymphomas in irradiated mice. IV. Genetic evidence of origin of tumor cells from thymic grafts (ab), Henry S. Kaplan et al, May, 795

—influence on oxygen consumption of spleen and thymus glands of rats (ab), Maurice V. Sullivan and Kenneth P. DuBois, Feb., 314

—irradiation and lipoprotein metabolism in various species (ab), John E. Hewitt and Thomas L. Hayes, April, 636

—lethal effects on rats of single and multiple exposures of 400-kv and 22-MV radiation (ab), W. S. Moos et al, Feb., 313

—method of measuring tissue-damaging action of x-rays (ab), H.-J. Heite and K. H. Nicolai, May, 793

—modification of acute intestinal radiation syndrome through shielding (ab), Marguerite N. Swift and S. Tom Taketa, April, 634

—prevention of intestinal radiation death by removal of irradiated intestine (ab), James W. Osborne, April, 634

—protective action of carbon monoxide in mammalian whole-body x-irradiation (ab), Eugene B. Konecni et al, Feb., 315

—reaction of mouse spleen to x-rays measured by changes in organ weight (ab), Robert F. Kallman and Henry I. Kohn, Feb., 314

ROENTGEN RAYS, effects—cont.

- relation of tumor size to tumor resistance, Charles M. Nice, Jr., April, 555
 - relative biological effectiveness of fast neutrons, x-rays, and γ -rays for acute lethality in mice (ab), A. C. Upton et al, Feb., 316
 - responses to whole-body irradiation in starved rat (ab), L. F. Nims and J. L. Ceisselsoder, May, 795
 - reticulum-cell sarcoma of rats; apparent inhibition by irradiation (ab), David V. Brown and Theodore A. Thorson, Feb., 313
 - similarities in killing by heat and by radiation in insect *Dahlbomimus fuscipennis* (Zett.) (ab), William F. Baldwin, May, 796
 - spreading effect of x-rays as measured by intradermal pressure (ab), H. Certa and H.-J. Heite, Jan., 155
 - studies on bone marrow lipid in normal and irradiated rabbits (ab), Frederick Bernheim et al, Feb., 314
 - temperature dependence of bacterial inactivation by x-rays (ab), G. E. Stapleton and C. W. Edington, June, 918
 - time-intensity factors in radiation response. I. Acute effects of megavolt electrons (cathode rays) and high- and low-energy x-rays with special reference to brain (ab), Samuel P. Hicks et al, Jan., 154
 - transplantability of canine thyroid carcinoma through 30 generations in mixed-breed puppies (ab), M. W. Allam et al, June, 918
 - urinary excretion and plasma levels of free ninhydrin reactive compounds in irradiated rats (ab), R. E. Kay et al, May, 796
 - use of small laboratory animals in medical radiation biology. IV. Correlation of physical factors with biological effect produced by total-body irradiation of guinea-pigs (ab), Friedrich Ellinger et al, June, 917
 - x-irradiation and liver regeneration in partially hepatectomized rats (ab), Leon L. Gershbein, April, 635
- films**
- disaster monitoring with amateur photographic film and with dental x-ray film, Margarete Ehrlich, Feb., 251
 - photographic badges for estimation of quality of x and gamma radiation (ab), B. W. Soole, June, 916
 - x-ray studies of photographic film; National Bureau of Standards, U.S. Department of Commerce, March, 422
- fluoroscopy.** See also Cardiovascular System; Thorax; other subheads under Roentgen Rays
- cerebral cineangiography with image intensifier (ab), H. Verbiest and J. Feddema, June, 907
 - dark adaptation with limited light and color vision, Frederic N. Silverman and Jerome Cohen, May, 733
 - shoe-fitting x-ray fluoroscopes; radiation measurements and hazards (ab), E. D. Dyson, June, 915
- high-voltage.** See Roentgen Therapy, high-voltage
- injurious effects.** See also Roentgen Rays, protection against
- damage to intrauterine fetus by roentgen rays (ab), Marko Basic and Danica Weber, Feb., 312
 - effect of antepartum diagnostic roentgenography on white blood cell count of newborn infant, Irwin H. Kaiser and James F. Marvin, Feb., 249
 - effect of radiation on esophagus; clinical and histologic study of effects produced by betatron, William B. Seaman and Lauren V. Ackerman, April, 534
 - experimental studies. See Roentgen Rays, effects
 - fatal pulmonary insufficiency due to radiation effect upon lung (ab), Daniel J. Stone et al, June, 915
 - genetic speculation based upon animal experimentation in relation to actual human experiences, in treatment of female infertility and sterility by x-ray therapy (ab), Ira I. Kaplan, April, 633
 - genetically significant radiation dose from diagnostic use of x-rays in England and Wales; preliminary survey (ab), S. B. Osborn and E. E. Smith, May, 793
 - osteogenic sarcoma of phalanx after chronic irradiation (ab), Robert E. Carroll et al, June, 915
 - pathological anatomy of changes involving pulmonary parenchyma after high doses of x-rays (ab), Harold Henzi, June, 915
 - roentgenographic examinations and radiation hazard (ab), J. Camerman, Jan., 153
 - roentgenoscopic examinations as hazard to patients (use of so-called chemical protector, mercaptoethylamin; trade name, Bécaptan disulfure Labax) (ab), Z. M. Bacq, May, 792
 - some effects of ionizing radiation on physiology of gastrointestinal tract: review (ab), Robert A. Conard, June, 916
- physics.** See also Dosimeters and Dosimetry; Ionization Chambers; Physics; Roentgen Therapy; other subheads under Roentgen Rays
- physical measurements on a 4-MEV linear accelerator, C. A. Murison and H. A. Hughes, March, 367
- protection against.** See also Roentgen Rays, effects
- attenuation of 86- and 176-MEV synchrotron x-rays in concrete and lead (ab), William Miller and Robert J. Kennedy, April, 636
 - dosages in diagnostic roentgenology (ab), R. Janker, March, 473
 - photographic personnel dosimeter for x-radiation in range from 30 kev to beyond 1 MEV, Margarete Ehrlich, Feb., 259
 - protection of ovaries from radiation (ab), Richard Batten and D. E. Meredith Brown, May, 791
 - radiation protection for general practitioner (ab), Lauriston S. Taylor, June, 916
 - x-ray exposure in dermatology personnel (ab), G. Thomas Jansen and Arthur C. Curtis, May, 792
- technic.** See also Body-Section Roentgenography; Brain, roentgenography; Cineradiography; Colon, roentgenography; Kymography; Spine, intervertebral disks
- improvement of definition by x-ray image magnification (ab), A. Nemet and W. F. Cox, April, 618
 - monochromatic roentgen rays in contrast media roentgenography (ab), Michel Ter-Pogossian, Feb., 301
- technicians.** See Technicians
- ROENTGEN THERAPY**
- See also Betatron; Cancer, radiotherapy; Radiotherapy; under diseases, organs, and regions
- cranial immobilization device for use in roentgen therapy, Bernard Roswit, Cyprian B. Reid and Stanley J. Malsky, March, 419
 - immobilization of head during rotational x-ray therapy, Harry L. Berman, April, 579
 - monitoring filters in roentgen therapy (ab), R. Thoraeus, March, 466
 - Monte Carlo calculations on spectrum of scattered radiation produced in water by x-ray beams of interest in radiotherapy, W. R. Bruce and H. E. Johns, Jan., 100
 - physical measurements on a 4-MEV linear accelerator, C. A. Murison and H. A. Hughes, March, 367
 - relation of tumor size to radioresistance, Charles M. Nice, Jr., April, 555
 - report on use of convergent beam therapy (ab), G. E. Flatman and R. E. Ellis, Jan., 148
 - rotation therapy with a 2 MEV Van de Graaff generator (ab), K. F. Orton, Feb., 307
 - x-rays in dermatology (ab), Herbert Rattner et al, May, 792
- dosage.** See also Dosimeters and Dosimetry; Ionization Chambers
- dosage data for 4 million volt x-rays (ab), D. Greene and F. W. Tranter, Feb., 308
 - dose distribution in conical rotation therapy at 2 MEV (from Van de Graaff generator), William Alan Jennings and Alice L. McCrea, Jan., 104
 - dose distribution in conical rotation therapy with a 2-MEV generator, W. A. Jennings and A. L. McCrea, May, 689
 - electronic isodose computer for planning multiportal radiation therapy, featuring instantaneous display of isodose curves with continuous variability of position and fractional dose in each field, Glen Sandberg and W. S. Moos, Jan., 103
 - percentage depth dose in moving-field therapy, W. Alan Jennings, May, 698
 - therapeutic use of single doses of total-body radiation (ab), Vincent P. Collins and R. Kenneth Loffer, Jan., 148
 - time-dose relationships (ab), Lucile A. Du Sault, Jan., 148
- grid therapy.** See Cancer, radiotherapy; Neck
- high-voltage.** See also Lungs, cancer; Roentgen Rays, effects; Roentgen Therapy, dosage
- clinical evaluation of results in supervoltage x-ray therapy (ab), G. W. Blomfield, Feb., 306
- ROGERS, JAMES V., Jr., and ROBERTO, ALBERT E.:** Circumscribed pulmonary lesions in periarteritis nodosa and Wegener's granulomatosis (ab), May, 765
- ROGERS, WILLIAM K., DOMM, SHELDON E., ROKITANSKY-ASCHOFF SINUSES.** See Gallbladder
- ROSE, J. DUDFIELD.** See MALLET-GUY, PIERRE
- ROSEBERG, BERTIL.** See KERNWEIN, GRAHAM A.
- ROSENBERG, NORMAN, REICH, RUDOLPH, and KROHN, MELVIN:** Prognosis and early diagnosis of nonunion of femoral neck fractures by laminography (ab), June, 902
- ROSENBLUM, DAVID, NUSSBAUM, ARNOLD, and SCHWARTZ, SOLOMON:** Partial obstruction of the inferior vena cava by herniation of the liver through the foramen of Morgagni. A case report, March, 399
- ROSENBERG, SIDNEY A., and SAMPSON, ARNOLD:** The syndrome of mesenteric vascular compression of the duodenum. Report of eleven cases with operative correction (ab), June, 896
- ROSENDAL, TH.** See BOESEN, IB
- ROSS, DONALD E.:** Cancer of the thyroid gland (ab), June, 912
- ROSS, F. G. M.:** Radiosensitive bone tumours—radiological aspects (ab), Feb., 302
- ROSS, S. W.** See TOCHILIN, E.
- ROSS, STEVEN.** See CAFFEY, JOHN
- ROSSALL, R. E., and GUNNING, A. J.:** Basal horizontal lines on chest radiographs. Significance in heart-disease (ab), April, 603
- ROSSI, HAROLD H., and FAILA, G.:** Tissue equivalent ionization chambers (ab), March, 465
- ROSSI, L., and MAGGIPIINTO, B.:** New radiologic methods in gynecology. Aortography and pelvic arteriography (ab), Feb., 299
- ROSWIT, BERNARD, REID, CYPRIAN B., and MALSKY, STANLEY J.:** A cranial immobilization device for use in roentgen therapy, March, 419
- See KAPLAN, GUSTAVE
- ROTATION THERAPY.** See Radioactivity, radiocobalt; Roentgen Therapy
- RÓTH, M., and JÓNA, I.:** Diagnostic value of percutaneous splenoportography (ab), April, 606
- ROTH, W.** See BREITNER, J.
- ROTHSCHILD, MARCUS A.** See BAUMAN, ARTHUR

- ROUNDS, WAYNE M., and EVANS, TITUS C.:** Recording of radioactivity in the blood, liver and prostate following interstitial administration of Au¹⁹⁸ in carcinoma of the prostate (ab), April, 629
- ROUSSEL, J., SCHOUMACHER, P., and PERNOT, Mme.:** Bone lesions secondary to cancer of uterus (ab), March, 453
- ROWE, CAROLINE W., and HAGGARD, MARY E.:** Bone infarcts in sickle-cell anemia, May, 661
- ROWE, GEORGE G., HUSTON, JOHN H., TUCHMAN, H., MAXWELL, GEORGE M., WEINSTEIN, ARVIN B., and CRUMPTON, CHARLES W.:** Physiological effect of contrast media used for angiocardiology (ab), April, 604
- RUBIDIUM.** See Radioactivity, radiorubidium
- RUBIN, PHILIP, and BESSE, BYRON E., Jr.:** Sialographic differentiation of Mikulicz's disease and Mikulicz's syndrome, April, 477
- RUBINSTEIN, CHARLES:** Some aspects of mass x-ray surveys for tuberculosis in New South Wales (ab), Feb., 283
- RUDOLPH, GUILFORD G., and OLSEN, NORMAN S.:** Transfer of potassium between blood, cerebrospinal fluid and brain tissue (ab), May, 789
- RUDY, HAROLD L.** See CLARKE, B. G.
- RÜBE, W.** See HACKENTHAL, H.
- RUFFATO, CESARE.** See PERUZZI, GASTONE
- RUGGIERO, GIOVANNI:** Diagnostic value of encephalographic examination of the subarachnoid space (ab), May, 753
- RUNDLE, F. F., SELDON, W. A., and INDYK, J. S.:** A radioiodine uptake test and its application in clinical diagnosis (ab), March, 467
- RUSSELL, MURRAY.** See KAUFMAN, JOSEPH J.
- RYAN, BERNARD K.** See STEINBERG, ISRAEL
- RYAN, JOSEPH M.** See MURPHY, THOMAS O.
- RYBAK, E.** See REMOLAR, JORGE
- RYDER, CHARLES T.** See CAFFEY, JOHN
- S**
- SABANAS, ALVINA O., BICKEL, WILLIAM H., and MOE, JOHN H.:** Natural history of osteoid osteoma of the spine. Review of literature and report of three cases (ab), June, 901
- SACHER, GEORGE A.** See GRAHN, DOUGLAS
- SACHS, MAURICE D., and PARTINGTON, PHILIP F.:** Cholangiographic diagnosis of pancreatitis (ab), June, 897
- SACROCOCYGEAL REGION**
—unusual bilateral sacrococcygeal ossicles, William S. Cornwell and George H. Ramsey, Jan., 70
- SAENGER, EUGENE L.** See FISHERWOOD, JOHN A.
- SALINGER, HANS, and FRIEDMAN-BAROU, HANNAH:** Use of different tube shifts in lung tomography, Feb., 209
- SALIVARY GLANDS**
—case of bilateral parotid calculi (ab), M. G. Varadarajan, April, 600
—further clinical studies of thyroid and salivary gland function with radioiodine (ab), C. H. Jaimes and H. G. Thode, April, 627
—iodide "mumps" after intravenous urography (ab), Ralph M. Sussman and Jay Miller, June, 905
—salivary and thyroidal radioiodine clearances of plasma in various states of thyroid function (ab), Karl Feltinger et al, Feb., 309
—sialographic differentiation of Mikulicz's disease and Mikulicz's syndrome, Philip Rubin and Byron E. Besse, Jr., April, 477
—sialography (ab), Joseph Winsten et al, Jan., 123
—sialography (ed), John F. Holt, 584
—technic of sialography (ab), A. Robinson Thomas, Feb., 279
- SALMONELLA**
—Salmonella bacteremia: case with miliary lung lesions and spondylitis, R. H. Greenspan and S. B. Feinberg, June, 860
- SALOTTI, AD., and LUNGHETTI, D.:** Functional roentgenologic findings in vascular disorders (ab), Jan., 131
- SALTZ, NATHAN J., LUTTWAK, EDMUND M., SCHWARTZ, ARMIN, and GOLDBERG, GIL M.:** Danger of aortography in the localization of pheochromocytoma (ab), May, 785
- SALZMAN, FERDINAND A.** See WISE, ROBERT E.
- SAMET, PHILIP, and ANDERSON, WILLIAM:** Pendular motion of the mediastinum (ab), April, 602
- SAMPSON, ARNOLD.** See ROSENBERG, SIDNEY A.
- SAMPSON, J. J., FELTON, L. R., GOLTZ, A. A., SOLOMON, R., and AXELRAD, B.:** Portable serial roentgenkymography in acute myocardial infarction (ab), March, 440
- SANDBERG, GLEN, and MOOS, W. S.:** An electronic isodose computer for planning multiportal radiation therapy, featuring instantaneous display of isodose curves with continuous variability of position and fractional dose in each field, Jan., 103
- SANDHAUS, SOL.** See MURPHY, THOMAS O.
- SANTAGADA, A., and PIAZZI, M.:** Contribution to the radiologic study of intrathoracic goiter with axial transverse stratigraphy (ab), Jan., 127
- SANTE, L. R.** See CHYNN, KUO-YORK
- SANTINI, L. C.** See HINKEL, C. L.
- SAPP, OSCAR L.** See CROSBY, WILLIAM H.
- SARCOIDOSIS**
—differential diagnosis between aluminum lung and Boeck's sarcoid; correction of article by K. H. Ehrecke (ab), F. Leicher, March, 438
—roentgenographic study of skeletal lesions in sarcoidosis (ab), George N. Stein et al, March, 453
- SARCOMA**
See also Tumors, experimental; under diseases, organs, and regions
- angiosarcoma**
—of bone: review of literature and presentation of case (ab), John H. Carter et al, May, 778
- Kaposi's**
—bone changes; analysis of 15 cases occurring in Bantu Africans (ab), A. G. M. Davies, May, 779
- lymphosarcoma.** See also Tumors, experimental
—clinical picture, therapy, and prognosis: experiences of Department of Radiation Therapy of University of Zurich from 1936 to 1951 (ab), Adolph J. Gretener, Jan., 147
—of large bowel (ab), Martins da Silva, May, 773
- osteosarcoma**
—osteomyelitis and sarcoma (ab), F. De Witte, Jan., 139
- reticulosarcoma**
—atypical reticulum-cell sarcoma of skeletal system (ab), G. Keiser and H. Hartmann, June, 898
—reticulum-cell sarcoma of rats; apparent inhibition by x irradiation (ab), David V. Brown and Theodore A. Thorson, Feb., 313
- spindle-cell**
—of vagina; case treated by radium implant (ab), Paul Strickland and H. C. Perry, Feb., 305
- SAUER, WILLIAM G.** See DEAN, DAVID L.
- SAWYER, KENNETH C., HAMMER, RAYMOND W., and FENTON, WARD C.:** Gastric volvulus as a cause of obstruction. Report of seven cases (ab), March, 447
- SCALP**
—perifolliculitis capitis abscedens et suffodiens: its successful treatment with x-ray epilation (ab), Francis H. McMullan and Israel Zeligman, May, 787
- SCAPHOID BONE, CARPAL**
—naviculo-capitate fracture syndrome (ab), Richard L. Fenton, April, 613
- SCARCELLA, GIUSEPPE:** Encephalomalacia simulating the clinical and radiological aspects of brain tumor. A report of six cases (ab), May, 759
- SCHÄRER, K.:** Radiation therapy of carcinoma of the esophagus (ab), Jan., 144
- SCHAFFNER, EDUARDO.** See LEBORGNE, FELIX E.
- SCHATTEN, WILLIAM.** See COLE, JACK W.
- SCHAUMAN, S.** See ORAVISTO, K. J.
- SCHERER, KURT E.** See BECKER, JOSEF
- SCHIEFF, SAUL, BEDNARZ, WALLACE W., and LEVENE, GEORGE:** Roentgenologic aspects of retropleural hematomas following sympathectomy, Feb., 224
- See LEVENE, GEORGE
- SCHERER, EBERHARD, FIEBELKORN, HANS-JOACHIM, and GÖBEL, BRUNO:** Contribution to the clinical features, prognosis, and therapy of struma maligna (ab), March, 463
- SCHICK, ROBERT E.:** Aftercare following intraluminal cobalt therapy for carcinoma of the bladder (ab), Feb., 312
- SCHIEFER, W.:** Diagnostic value of functional serial angiography in intracranial lesions (ab), May, 755
- SCHIFFER, K. H.:** Developmental changes of the skull as seen on roentgenograms (ab), May, 760
- SCHILDER, DONALD P., HARVEY, W. PROCTOR, and HUFNAGEL, CHARLES A.:** Rheumatoid spondylitis and aortic insufficiency (ab), May, 781
- SCHIRREY, CARL G.** See van CANEHEM, PIERRE
- SCHLOSSER, RALPH J., and HARKINS, HENRY N.:** Pulmonary arteriovenous aneurysm. Report of six cases (ab), June, 893
- SCHLUGER, JOSEPH, ARCOMANO, JOSEPH, and CARDON, ORSON P.:** Leiomyoma of the esophagus (ab), March, 446
- SCHMIDT, ERNST A.:** The differential x-ray diagnosis of pulmonary carcinoma (ab), Jan., 125
- SCHMIDT, HERBERT W.** See BRÜWER, ANDRÉ J.
- SCHMITZ, HERBERT E.:** Opportunity and cervix cancer (ab), April, 619
- SCHNEIDER, MARTIN, and CEBALLOS, JORGE:** Bi-axial roentgenkymography: an aid in differential diagnosis of solid mediastinal tumor and aneurysm (ab), Feb., 286
- SCHOEN, IRWIN.** See ISAAC, FRANK
- SCHOENBERGER, JAMES A., KROL, GEORGE, ECKERT, EDWARD L., and KARK, ROBERT M.:** Investigation of transfer rates of albumin tagged with I¹³¹ in ascites and edema. II. Studies in control subjects and patients with cirrhosis (ab), March, 469
- SCHOOLMAN, HAROLD M., and SCHWARTZ, STEVEN O.:** Aplastic anemia secondary to intravenous therapy with radiogold. Report of a case (ab), Jan., 152
- SCHORR, S., FRÄNKEL, M., and ADLER, E.:** Right unilateral thoracic spondylitis (ab), May, 781
- See ABRAMOV, A.
- SCHOUMACHER, P.** See ROUSSEL, J.
- SCHRÖDER, G., and ANDERSCH, H.:** Diffuse progressive interstitial pulmonary fibrosis (Hamman-Rich syndrome) (ab), April, 601
- SCHUBERT, G., KÜNKEL, H. A., OVERBECK, L., and UHLMANN, G.:** Investigation into experimental production of cancer by local beta irradiation (ab), May, 794
- SCHUCH, ROBERT M.** See ANDERSON, ERNEST C.
- SCHULTZ, ALVIN L.** See ZIEVE, LESLIE

- SCHULTZ, E. C., and HUSTON, WILLIAM A.:** Arteriovenous aneurysm of the posterior fossa in an infant. Report of a case (ab), Jan., 121
- SCHULTZ, R. J. See MEURK, M. L.**
- SCHULTZE, GUNTER. See DAVES, MARVIN L.**
- SCHULZE, H.-E.:** Concerning the roentgen diagnosis of intracranial dermoids (so-called cholesteatoma) (ab), Feb., 278
- SCHWARTZ, ARMIN. See SALTZ, NATHAN J.**
- SCHWARTZ, LEONARD H. See JACOBSON, GEORGE**
- SCHWARTZ, MILES J. See STONE, DANIEL J.**
- SCHWARTZ, SOLOMON. See ROSENBLUM, DAVID**
- SCHWARTZ, STEVEN O. See SCHOOLMAN, HAROLD M.**
- SCHWENKENBECHER, HELLMUT:** Results of radiotherapy of brain tumors 1945-1954 (ab), May, 785
- SCIATICA**
—treatment of low-back and sciatic pain by injection of hydrocortisone into degenerated intervertebral disks (ab), Henry L. Feffer, April, 612
- SCINTILLATION COUNTERS. See Counters**
- SCLERODERMA**
—pericardial effusion in generalized scleroderma (ab), Jay I. Meltzer, Feb., 287
—scleroderma (progressive systemic sclerosis) associated with cancer of lung; brief review and report of case (ab), Sigmund M. Jonsson and Joseph M. Houser, June, 889
- SCLEROSIS, TUBEROUS**
—pulmonary tuberosus sclerosis; case (ab), André J. Bruwer et al, Feb., 283
- SCOLIOSIS. See Spine, curvature**
- SCROTUM**
—carcinoma (ab), Gustave Kaplan et al, Feb., 306
- SCUDERI, CARLO:** Herniated lumbar intervertebral disks. An eight-year survey (ab), Feb., 296
- SEALANDER, JOHN A., Jr.:** Influence of temperature stress on uptake of P^{32} in the rat (ab), June, 918
- SEAMAN, WILLIAM B., and ACKERMAN, LAUREN V.:** Effect of radiation on the esophagus. A clinical and histologic study of the effects produced by the betatron, April, 534
—and EAGLETON, MARK D.: Radiation therapy of neuroblastoma, Jan., 1
- See POWERS, WILLIAM E.**
- SECREST, PETTUS G. See KENDIG, TOM A.**
- SEIBERT, R. A. See SMITH, E. L.**
- SEIDEL, KARL:** Depth doses in roentgen grid irradiation (ab), Feb., 309
- SELDON, W. A. See RUNDLE, F. F.**
- SELLA TURCICA**
—encephalography of sellar and parasellar tumors, with particular reference to anteroposterior projection and olfactory sulci (ab), Joseph Hanelin and Louis Bakay, May, 754
- SILVERSTONE, B., YUAN, R. H. P., and ROBINSON, C. V.:** Improved syringe for angiography (ab), March, 461
- SENDRA, L. See PHELINE, CH.**
- See VIALLET, P.**
- SEPP, PETER:** The phosphamidase in cells of vaginal smears in cervix carcinoma before and after radiotherapy (ab), Jan., 146
- SEPÚLVEDA, BERNARDO. See FALOMIR, JOSÉ M.**
- SESAMOID BONE. See Fibula**
- SETÄLÄ, KAI, and SIURALA, MAX:** Roentgenologic signs of chronic gastritis (ab), Jan., 131
- SEX**
—sex difference in response to titrated irradiation therapy (^{137}Cs) of patients with chronic granulocytic leukemia (ab), William H. Crosby et al, May, 788
- SEYMOUR, P. H. See BOND, V. P.**
- See CARTER, R. E.**
- SHACKFORD, B. C. See KENDIG, TOM A.**
- SHAPIRO, B. J., and SIMOR, E. S.:** Thrombosis of internal carotid artery (ab), Jan., 130
- SHAPIRO, JEROME. See NETSKY, MARTIN G.**
- SHAPIRO, JEROME H. See JACOBSON, HAROLD G.**
- See POPPEL, MAXWELL H.**
- SHAPIRO, ROBERT. See GLASSMAN, IRVING**
- SHARP, ANDREW G., ANDERSON, EMORY H., ACKER, EARLE D., and THIELEN, ARTHUR J.:** The importance of the translumbar aortogram and peripheral arteriogram in the management of vascular disease (ab), May, 768
- SHAW, E. G., and TAYLOR, J. G.:** Results of lumbo-sacral fusion for low back pain (ab), March, 455
- SHAW, ROBERT S.:** Vascular responses to intra-arterial Diodrast and Urokon during arteriography (ab), March, 443
- SHEK, JOHN L., COPE, JEROME A., and MYERS, GORDON D.:** Giant air cyst(s) as a sequela of pulmonary tuberculosis (ab), May, 766
- SHELDON, PHILIP. See JEFFERSON, ANTONY**
- SHEPARD, EDMUND:** Multiple epiphyseal dysplasia (ab), March, 452
- SHERMAN, ROBERT S., and SOONG, KENNETH Y.:** Aneurysmal bone cyst: its roentgen diagnosis, Jan., 54
—and WILNER, DANIEL: Roentgenological diagnosis of hyperplasticity of the stomach (ab), Feb., 290
- SHIRER, J. F. See ALLAM, M. W.**
- SHOE-FITTING. See Roentgen Rays, fluoroscopy**
- SHORT, D. S.:** Radiology of the lung in left heart failure (ab), Feb., 287
- SHOULDER**
—arthrography as diagnostic aid in tendon injuries (ab), Graham A. Kernwein et al, Feb., 297
—posterior dislocation (ab), Sylvester J. O'Connor and Albert S. Jacknow, Feb., 297
- SHUMWAY, B. W., and GOLDEN, R.:** Electron beam dosimetry of a 2-Mev Van de Graaff accelerator, Jan., 104
—See TOCHILIN, E.
- SHUNTS. See Blood, circulation**
- SHWACHMAN, HARRY, PRYLES, CHARLES V., and GROSS, ROBERT E.:** Meconium ileus. A clinical study of twenty surviving patients (ab), Jan., 132
- SIALOGRAPHY. See Salivary Glands**
- SIDEROSIS**
—pulmonary changes in welders; 3 cases (ab), Robert Charr, April, 602
- SIEGEL, ELSE P., HART, HIRAME, BROTHERS, MILTON, SPENCER, HERTA, and LASZLO, DANIEL:** Radio-yttrium (Y^{90}) for the palliative treatment of effusions due to malignancy (ab), April, 630
- DI SIENO, ANTONIO, and GUARESCHI, BRUNO:** The radiologic picture of medullary sponge kidney: review of the literature and presentation of two cases (ab), Jan., 141
- SIGMOID**
—value of lateral view of rectosigmoid (ab), G. Osborne et al, Feb., 293
—vertebral osteomyelitis following operation on urinary tract or sigmoid; third lesion of uncommon syndrome (ab), Edwin L. Lame, March, 454
- cancer**
—intussusception as cause of "disappearing" carcinoma of rectum (sigmoid) (ab), Harvey J. Dworken, Feb., 293
- SILICOSIS. See Pneumoconiosis**
- da SILVA, MARTINS:** Lymphosarcoma of the large bowel (ab), May, 773
- SILVER, MAURICE L. See GOLDIN, RALPH R.**
- SILVERMAN, FREDERIC N., and COHEN, JEROME:** Dark adaptation with limited light and color vision, May, 733
—See TAYEBI, HOOSHANG
- SILVERMAN, WILLIAM A. See CAFFEY, JOHN**
- SILVIS, RICHARD S., HUGHES, WILLIAM F., and HOLMES, FRANCIS H.:** Aneurysm of the renal artery (ab), Jan., 142
- SIMAS, WILSON. See HOFFMAN, HOWARD A.**
- SIMOR, E. S. See SHAPIRO, B. J.**
- SIMPSON, ELLEN. See KEATS, THEODORE E.**
- SIMPSON, JOHN W. See ISHERWOOD, JOHN A.**
- SINGLETON, A. O., Jr., and COLEMAN, JAMES L.:** Residual common duct calculi (ab), March, 449
- SINGLETON, EDWARD B.:** The radiographic features of severe idiopathic hypercalcemia of infancy, May, 721
—and BILES, E. WILEY: Mediastinal tumors in children (ab), June, 891
—and HARRISON, GUNYON H.: Excretory pyelography in infants. Technique for intravenous injection (ab), March, 458
- SINUSES, PARANASAL**
—inflammatory cranioopathies. Various stages in development of theory (ab), Mario Bertolotti, Feb., 278
—role of sinusitis in bronchiectasis (ab), R. M. Versteegh and J. Swierenga, June, 891
- cancer**
—treatment of cancer of nasal cavity and paranasal sinuses (ab), James W. Hendrick, Jan., 143
- SINUS TRACTS**
—interdigital sinuses in barber's hand (ab), H. D. W. Powell, Jan., 140
- SIURALA, MAX. See SETÄLÄ, KAI**
- SIWE-LETTERER DISEASE. See Reticuloendothelial System**
- SJÖGREN, S. E.:** The anterior choroidal artery (ab), May, 761
—See AZAMBUJA, N.
- SKARSGARD, L. D., CORMACK, D. V., and JOHNS, H. E.:** Measurement of the ratio B_{α}/J_m for betatron radiation, Feb., 257
- SKELETON. See Bones**
- SKIN**
—See also Urticaria
—irradiation of advanced cancer of head and neck through grid. Part I. Study of absorbed dose by observation of skin and mucosal reactions, Milton Friedman and Alexander W. Pearlman, June, 852
—skin replacement for severe radiation dermatitis of face (ab), John J. Conley, March, 475
—spreading effect of x-rays as measured by intradermal pressure (ab), H. Certa and H. J. Heite, Jan., 155
—treatment of skin tumors of inner canthus with regard to function of lacrimal ducts (ab), Hansrudolph Renfer, Jan., 143
—x-ray exposure in dermatology personnel (ab), G. Thomas Jansen and Arthur C. Curtis, May, 792
—x-rays in dermatology (ab), Herbert Rattner et al, May, 792
- SKLAROFF, DAVID M.:** Treatment of hemangiomas with the strontium-90 beta-ray applicator, Jan., 87
- SKOKAN, Z. V., and STOLZ, J.:** Branchiogenic intrathoracic mediastino-thymic cyst (ab), May, 767
- SKULL. See Cranium**
- SLADE, HARRY W., and GLAZER, NORMAN M.:** Paraphysal cyst of the third ventricle (ab), Jan., 122

- SLANINA, JOSEF:** Fabella distalis: a new sesamoid bone (ab), May, 784
- SLATER, GREGORY S.** See **KRAFT, ERNEST**
- SLOAN, HERBERT.** See **FIGLEY, MELVIN M.**
- SLOSS, PIERCE T.** See **WEED, LYLE A.**
- SMART, JOSEPH, and HILTON, GWEN:** Radiotherapy of cancer of the lung. Results in a selected group of cases (ab), May, 785
- and PATTINSON, J. N.:** Congenital absence of left pulmonary artery (ab), Jan., 130
- SMITH, E. E.** See **OSBORN, S. B.**
- SMITH, E. L., and DEEVERS, S.:** Determination of cell volume in massive transfusions using Fe^{59} and Cr^{51} (ab), May, 790
- SMITH, GEORGE W., and NICHOLS, POMEROY, JR.:** The technic of cervical discography, May, 718
- SMITH, J. CHANDLER:** Superiority of surgical treatment of endometrial carcinoma (ab), Feb., 304
- SMITH, SIDNEY A.** See **BROOKS, PHILLIPS M.**
- SMITH, VERNON H.** See **GOLDBERG, H. M.**
- SMOLIK, EDMUND A., MUETHER, RAYMOND O., NASH, FRANCIS P., and KONNEKER, WILFRED:** Blood volume changes in cases of cerebral trauma as determined by radioactive isotopes (ab), Jan., 152
- SMYTH, IVOR P.:** Bilateral osteochondritis of the middle cuneiform bone. Case report, April, 575
- SNEED, WILLIAM R., JR.** See **KERNWEIN, GRAHAM A.**
- SNIDER, RAY S.** See **LEE, JOHN C.**
- SNOW, WILLIAM, and HOLLINGSWORTH, JOHN C.:** Self-retaining barium-enema tip: improvement, March, 418
- SODIUM ACETRIZOATE.** See **Pyeelography**
- SODIUM DITHIONATE (Hypaque).** See **Pyeelography**
- SODIUM, RADIOACTIVE.** See **Radioactivity, radiosodium**
- SØRENSEN, EDVIN.** See **AMUNDSEN, P.**
- SOILA, PEKKA:** Pantomography of deep layers. A preliminary report (ab), March, 461
- SOKOLOFF, MARTIN J.** See **STEIN, SAMUEL C.**
- SOLOFF, LOUIS A., and ZATUCHNI, JACOB:** The angiocardigraphic diagnosis of left atrial thrombosis (ab), May, 767
- ZATUCHNI, JACOB, STAUFFER, HERBERT M., and KELLY, EUGENE W.:** Angiocardigraphic observations of intracardiac flow in the normal and in mitral stenosis (ab), Jan., 128
- SOLOMON, R.** See **SAMPSON, J. J.**
- SONES, MAURICE.** See **STEIN, GEORGE N.**
- SOOLE, B. W.:** Photographic badges for the estimation of the quality of x and gamma radiation (ab), June, 916
- SOONG, KENNETH Y.** See **SHERMAN, ROBERT S.**
- SOSIN, ALLEN.** See **MARTNER, EDGAR E.**
- SOTEROPOULOS, C., KAWASHIMA, E., and GILMORE, JOHN H.:** Cystitis and urethritis emphysematosa, June, 866
- SOWERBUTTS, J. G.** See **GREEN, B.**
- SPARKMAN, ROBERT S., and ELLIS, PAUL R.:** Intravenous cholecyst-cholangiography in emergency abdominal diagnosis (ab), March, 450
- SPASM.** See **Bronchi**
- SPECTROMETRY**
- scintillation spectrometer, measuring instrument in radiological practice (ab), Walter Kolb, 911
- SPECTRUM AND SPECTRUM ANALYSIS**
- Monte Carlo calculations on spectrum of scattered radiation produced in water by x-ray beams of interest in radiotherapy, W. R. Bruce and H. E. Johns, Jan., 100
- SPENCER, HERTA.** See **SIEGEL, ELSIE P.**
- SPENSLEY, ROBERT D., NELSON, ROBERT E., and CHILDS, WESLEY A.:** Unusual causes of free intraperitoneal air in acute conditions of the abdomen (ab), Jan., 131
- SPIERS, F. W.:** Radioactivity in man and his environment (ab), June, 914
- SPINA BIFIDA**
- incidence of spina bifida occulta in relation to age (ab), Wataru W. Sutow and Arthur W. Pryde, Jan., 139
- SPINAL CANAL ROENTGENOGRAPHY**
- See also **Spinal Cord; Spine, intervertebral disks**
- cervical oil myelography with full hyperextension of neck; modified technic (ab), F. Dulith, May, 762
- SPINAL CORD**
- abnormal swallowing in central-nervous-system and neuromuscular disease (ab), Maxwell H. Poppel et al, Jan., 123
- measurement of cervical spinal cord in Pantopaque myelography (ab), Edward C. Porter, June, 902
- tumors**
- importance of myelography in spinal pathology; analytical study of 150 cases (ab), F. J. Borrelli and A. A. Maglione, June, 900
- myelographically demonstrated lesions of cervical intervertebral disks, co-existing with tumors and other causes of myelopathy (ab), Fritz Cramer and Frank Hudson, May, 783
- myelography of complete spinal obstruction (ab), Arthur S. Tucker, June, 900
- pinealoma with metastases in central nervous system; rationale of treatment (ab), Fred D. Fowler et al, March, 462
- roentgen study in children (ab), J. Lefebvre et al, May, 784
- wounds and injuries**
- contrast medium injury to spinal cord produced by aortography; pathologic anatomy of experimental lesion (ab), G. Margolis et al, May, 770
- SPINE**
- See also **Atlas and Axis; Sacrococcygeal Region**
- accessory bones of intervertebral disks and spondylosis deformans (ab), G. Teichert, Feb., 296
- hoarseness and painful deglutition due to massive cervical exostoses (ab), Charles V. Heck, April, 600
- results of lumbosacral fusion for low back pain (ab), E. G. Shaw and J. G. Taylor, March, 455
- right unilateral thoracic spondylosis (ab), S. Schorr et al, May, 781
- studies in dynamics of spine (ab), Jan Jirout, May, 780
- vertebral changes in childhood leukemia, Bernard S. Epstein, Jan., 65
- abnormalities**
- accessory bones of intervertebral disks and spondylosis deformans (ab), G. Teichert, Feb., 296
- congenital deformities of surgical importance (ab), Thomas N. Cowie, May, 780
- etiology of osseous bridges between lumbar transverse processes (ab), E. de Cuveland, May, 781
- arthritis**
- osteo-arthritic occlusion of intervertebral foramina of cervical spine (ab), Geoffrey Doel, May, 781
- rheumatoid spondylitis and aortic insufficiency (ab), Donald P. Schilder et al, May, 781
- cancer**
- vertebral metastasis in renal carcinoma: anatomic correlation (ab), George T. Wohl, March, 454
- vertebral trephine biopsy (for determination of cancer metastasis) (ab), Wolfgang Ackermann, March, 455
- curvature**
- paralytic scoliosis (ab), J. I. P. James, June, 899
- paralytic scoliosis (ab), Robert Roaf, June, 899
- cysts**
- extradural cysts of spine (ab), G. Lombardi and A. Passerini, March, 453
- disinfection**
- infectious spondylitis following damage to anterior longitudinal ligament (contribution to spondylitis following paravertebral anesthesia) (ab), W. Postmann, May, 783
- non-specific spondylitis in children (ab), H. Wissler, April, 612
- Salmonella bacteremia: case with miliary lung lesions and spondylitis, R. H. Greenspan and S. B. Feinberg, June, 860
- dislocations**
- headache from subluxation of cervical articulations (ab), Ákos Kovács, June, 887
- spondylolisthesis: autopsy study. Preliminary report, Palmer E. Wigby and John R. Thomas, Jan., 94
- tuberculosis at site of spondylolisthesis (ab), A. H. C. Ratliff, Jan., 139
- fractures**
- hidden anvil fracture of seventh cervical vertebral body (ab), M. C. Harrison and Ian Macnab, March, 454
- in children (ab), Otto Lehmann, April, 611
- intervertebral disks**
- accessory bones of intervertebral disks and spondylosis deformans (ab), G. Teichert, Feb., 296
- asymptomatic disk protrusions (ab), Donald L. McRae, May, 782
- clinical significance of discography (ab), L. Walk, May, 782
- herniated lumbar disks: 8-year survey, Carlo Scuderi, Feb., 206
- importance of myelography in spinal pathology; analytical study of 150 cases (ab), F. J. Borrelli and A. A. Maglione, June, 900
- myelographically demonstrated lesions of cervical disks, co-existing with tumors and other causes of myelopathy (ab), Fritz Cramer and Frank Hudson, May, 783
- myelography of complete spinal obstruction (ab), Arthur S. Tucker, June, 900
- roentgen diagnosis of herniated disk with particular reference to discography (nucleography) (ab), William G. Peacher and Richard P. Storr, June, 901
- suboccipital gas myelography in diagnosis of herniated disk in cervical segment (ab), H. H. Jacobsen, May, 783
- technic of cervical discography, George W. Smith and Pomeroy Nichols, Jr., May, 718
- treatment of low-back and sciatic pain by injection of hydrocortisone into degenerated disks (ab), Henry L. Feffer, April, 612
- osteomyelitis**
- vertebral osteomyelitis following operation on urinary tract or sigmoid; third lesion of uncommon syndrome (ab), Edwin L. Lame, March, 454
- roentgenography.** See also other subheads under **Spine**
- comparative roentgen findings in symptomatic and asymptomatic backs, Tom M. Fullenlove and A. Justin Williams, April, 572
- tuberculosis**
- at site of spondylolisthesis (ab), A. H. C. Ratliff, Jan., 139
- tumors**
- natural history of osteoid osteoma of spine; review of literature and report of 3 cases (ab), Alvina O. Sabanas et al, June, 901
- SPLEEN**
- effect of total-body x irradiation on plasma volume, red cell volume, blood volume and thiocyanate space in normal and splenectomized rats (ab), Kee-Chang Huang and James H. Bondurant, April, 635

SPLEEN—*cont.*

- incorporation of N^{15} -labeled glycine in plasma protein, plasma phospholipids, blood nonprotein nitrogen, and splenic tissue in man (ab), D. S. Amatuzio et al, March, 472
- influence of x-ray on oxygen consumption of spleen and thymus glands of rats (ab), Maurice F. Sullivan and Kenneth P. DuBois, Feb., 314
- pancreaticosplenectomy combined with gastrectomy in cancer of stomach (ab), Komei Nakayama, June, 894
- reaction of mouse spleen to x-rays measured by changes in organ weight (ab), Robert F. Kallman and Henry I. Kohn, Feb., 314
- roentgenographically demonstrable splenic deposits in sickle-cell anemia (ab), George Jacobson and Sidney D. Zucherman, June, 905
- roentgenography.** See also other headings under spleen
 - colloidal stannic oxide; animal studies on new hepatolienographic agent, Harry W. Fischer, April, 488
 - diagnostic value of percutaneous splenopography (ab), M. Roth and I. Jona, April, 606
 - does "laparoscopic" splenopography indicate an advance in field of medical x-ray diagnosis? Contribution to early diagnosis of intrahepatic obstruction (ab), L. Wannagat, March, 451
 - extrahepatic portal hypertension (portal vein thrombosis) diagnosed by percutaneous splenic venography (ab), Hector F. Rodriguez et al, April, 606
 - splenopography for diagnosis of portal hypertension (ab), José M. Falomir et al, May, 777
 - splenopography: valuable adjunct in study of portal hypertension (ab), Hector F. Rodriguez et al, May, 776
- rupture**
 - roentgenologic diagnosis of ruptured spleen (ab), C. C. Wang and Laurence L. Robbins, Jan., 137
- SPONDYLITIS.** See Spine
- SPONDYLOLISTHESIS.** See Spine, dislocations
- SPONDYLOSIS.** See Spine
- SPRAFKA, JOSEPH L.** See LEVY, LOUIS M.
- SPRUNT, WILLIAM H., III.** See BREAM, CHARLES A.
- STAGGERS, FRANK E.** See HAHN, P. F.
- STALEY, CHARLES J.** Skeletal metastases in cancer of the breast (ab), April, 610
- STANBURY, JOHN B., MEIJER, J. W. A., AND KASSENBAAR, A. A. H.** The metabolism of iodotyrosines II. The metabolism of mono- and di-iodotyrosine in certain patients with familial goiter (ab), June, 912
- STANDER, RICHARD W.** Vaginal metastases following treatment of endometrial carcinoma (ab), Feb., 304
- STANNIC OXIDE.** See Tin
- STANSFELD, ALFRED G.** See MAUDSLEY, ROY H.
- STAPHYLOCOCCI**
 - experimental staphylococcal bullous pneumopathy (ab), R. Herbeval and G. Dehry, May, 767
- STAPLETON, G. E., and EDINGTON, C. W.** Temperature dependence of bacterial inactivation by x-rays (ab), June, 918
- STARKE, ERNEST, VAN BUSKIRK, FREDERICK W., and DALY, JOHN F.** Radiologic and pathologic bone changes associated with urticaria pigmentosa. Report of a case (ab), June, 899
- STARRE, PAUL.** See CATZ, BORIS
- STARVATION**
 - responses to whole-body x-irradiation in starved rat (ab), L. F. Nims and J. L. Geisselsoder, May, 795
- STAUFFER, H. M.** See OPPENHEIMER, M. J.
- See SOLOFF, LOUIS A.
- STEELMAN, SANFORD L.** See BEST, WILLIAM R.
- STEGMAN, KENNETH F.** See CARNESALE, PETER L.
- STEIN, GEORGE N., ISRAEL, HAROLD L., and SONES, MAURICE.** A roentgenographic study of skeletal lesions in sarcoidosis (ab), March, 453
- STEIN, JOSEPH.** See POPPEL, MAXWELL H.
- STEIN, JUSTIN J.** See WARREN, STAFFORD L.
- STEIN, SAMUEL C., and SOKOLOFF, MARTIN J.** Calcification of regional lymph nodes following BCG vaccination (ab), Jan., 124
- STEINBACH, HOWARD L., and JOHNSTONE, HERBERT G.** Roentgen diagnosis of Armillifer infection (porocephalosis) in man, Feb., 234
- See JONES, MALCOLM D.
- STEINBERG, ISRAEL, and FINBY, NATHANIEL.** Angiocardiography in the diagnosis of saccular aneurysm of the abdominal aorta. Report of a case (ab), June, 892
- Clinical manifestations of the unperforated aortic sinus aneurysm (ab), May, 770
- See MERTEN, CHARLES W.
- and RYAN, BERNARD K.: Corner positioning for visualization of the brachiocephalic vessels, Feb., 242
- STEINGRABER, O. J.** See MILLER, C. E.
- STERILITY**
 - genetic speculation based upon animal experimentation in relation to actual human experiments, in treatment of female infertility and sterility by x-ray therapy (ab), Ira I. Kaplan, April, 633
- STERN, AARON M.** See FIGLEY, MELVIN M.
- STERN, WILHELM.** See JACOBSON, HAROLD G.
- STERNUM**
 - technic and normal radiographic anatomy of sternum (ab), Emilio Balzarini and Giuseppe Pompili, May, 780
- STEVENS, KEITH A.** See MOWATT, KEITH S.

- STEWART, A. M., and WYNN-WILLIAMS, A.** Combined tricuspid and pulmonary atresia with juxtaposition of the auricles (ab), April, 605
- STEWART, G. H., III.** See OPPENHEIMER, M. J.
- STEWART, H. B., and COLE, E. R.** Progressive diaphragmatic dysplasia (Engelmann's disease) (ab), Feb., 295
- STICKLEY, E. E.** Neutron capture therapy: slow neutron depth distribution measurements in tissue (ab), Jan., 150
- STOLL, BASIL A.** New drugs for irradiation sickness, March, 380
- Radiosensitivity of granulosa-cell tumor of the ovary (ab), April, 620
- STOLZ, J.** See SKOKAN, Z. V.
- STOMACH**
 - See also Gastrointestinal Tract
 - delayed visualization of gallbladder due to gastric retention (ab), S. A. Leader, May, 774
 - effects of artificial gaseous distension of stomach and its role in making liver radiologically visible (ab), N. R. Konar et al, Feb., 292
 - tubeless gastric analysis in study of acid secretion following gastric irradiation for peptic ulcer (ab), John T. Galambos and Joseph B. Kirsner, Feb., 306
- calcification.** See Stomach, cancer
- cancer.** See also Peptic Ulcer, cancer and peptic ulcer
 - calcification in carcinoma; case report, Tom A. Kendig, Max R. Gaspar, Pettus G. Secrest and B. C. Shackford, Jan., 80
 - carcinoma of esophagus and gastric cardia (ab), Denis Pellerin, June, 908
 - diagnostic significance of radioactive isotopes in early cancer of alimentary tract, especially esophagus and cardia (ab), Komei Nakayama, April, 630
 - difficulties in diagnosis of carcinoma in region of cardia (ab), Conway Don and D. J. L. Murphy, March, 446
 - of gastric stump (ab), E. de Arzua Zulaica, Feb., 291
 - pancreaticosplenectomy combined with gastrectomy in cancer of stomach (ab), Komei Nakayama, June, 894
 - results of surgery in carcinoma discovered by periodic roentgen examination (ab), John R. Amberg and Leo G. Rigler, April, 607
- cardiospasm**
 - achalasia of cardia and mega-esophagus; 5 representative cases (ab), Charles H. Brown and C. Peter Albright, May, 772
- diseases**
 - primary amyloidosis; case of gastric involvement only (ab), Anthony D. Intriore and Charles H. Brown, March, 447
- inflammation**
 - roentgenologic signs of chronic gastritis (ab), Kai Setälä and Max Siurala, Jan., 131
- mucosa**
 - roentgenological diagnosis of hyperrugosity (ab), Robert S. Sherman and Daniel Wilner, Feb., 290
- obstruction.** See Stomach, volvulus
- roentgenography.** See also other subheads under Stomach
 - pharmacoradiography (ab), J. Pfeiffer, Feb., 292
 - roentgenologic findings in stomach and duodenum in cancer of pancreas (ab), Kaare A. Larsen and Arne Pedersen, April, 608
 - roentgenologically demonstrable gastric abnormalities in cases of previous congenital pyloric stenosis (ab), O. Steinicke Nielsen and M. Roelsgaard, Feb., 290
 - transverse colon in right inguinal hernia with confusing distortion of stomach (ab), Ralph V. Gieselmann et al, Feb., 292
- surgery**
 - closed loop obstruction of afferent limb; late complication of antecolic partial gastrectomy (ab), N. Hajdu et al, June, 895
 - peptic ulcer, partial gastrectomy, and pulmonary tuberculosis (ab), P. A. Thorn et al, Jan., 124
- ulcers.** See Peptic Ulcer
- volvulus**
 - acute volvulus (ab), H. M. Goldberg and Vernon H. Smith, March, 447
 - as cause of obstruction; 7 cases (ab), Kenneth C. Sawyer et al, March, 447
 - some diagnostic difficulties in cases with cascade stomach and chronic gastric volvulus (ab), Paul M. Davies, June, 894
- STONE, DANIEL J., SCHWARTZ, MILES J., and GREEN, ROBERT A.** Fatal pulmonary insufficiency due to radiation effect upon the lung (ab), June, 915
- STONER, RICHARD D.** See WILLIAMS, WILLIAM L.
- STORAASLI, JOHN P., and KING, DONALD P.** Four cases illustrating the use of I^{131} in the management of metastatic carcinoma of the thyroid (ab), April, 628
- STORM, OLE.** See BOESEN, IB
- STORRS, RICHARD P.** See PEACHER, WILLIAM G.
- STRANG, CHRISTOPHER.** The fate of children with bronchiectasis (ab), April, 602
- STRATIGRAPHY.** See Body Section Roentgenography
- STRICKLAND, PAUL, and PERRY, H. C.** Spindle cell sarcoma of the vagina. A case treated by radium implant (ab), Feb., 305
- STRIDOR.** See Larynx
- STRITTMATTER, W. C., BROWN, C. H., and TRETBAR, H. A.** A large carcinoma of the adrenal. Report of a case, Feb., 231
- STRONTIUM.** See Radioactivity, radiostrontium

- STRUMA MALIGNA.** See Thyroid, cancer
- STUART, CHARLES:** Acute pancreatitis. Preliminary investigation of a new radiodiagnostic sign (ab), May, 773
- STUART, F. G.:** Osteoid osteoma of the ischium with hip joint complications (ab), April, 613
- STUBBS, E. L.** See **ALLAM, M. W.**
- SUBARACHNOID SPACE.** See Meninges
- SÜSSE, H. J.:** Dangers and technic of osteomyelography and transosseous venography (ab), June, 906
- SULCUS, OLFACTORY.** See Brain, tumors
- SULFIDES**
—disulfide reduction and release of iodide 131 following irradiation of ^{131}I labeled proteins, Rosalyn S. Yalow and Solomon A. Berson, Jan., 100
- SULFUR, RADIOACTIVE.** See Radioactivity, radiosulfur
- SULLIVAN, MAURICE F., and DuBOIS, KENNETH P.:** Influence of x-ray on oxygen consumption of spleen and thymus glands of rats (ab), Feb., 314
- SUMMATION IMAGE.** See Roentgen Rays, diagnosis
- SUPPLES, HELEN, WEINMAN, E. O., and ENTENMAN, C.:** Enlargement of the liver in Sprague-Dawley rats following whole-body x-irradiation (ab), April, 635
- SURGERY**
See also under diseases, organs, and regions, as Stomach, surgery; Uterus, cancer
—skin replacement for severe radiation dermatitis of face (ab), John J. Conley, March, 475
—surgical management of local postradiation effects (ab), J. J. Longacre, May, 792
- SUSSMAN, BERNARD J.** See **FEIRING, EMANUEL H.**
- SUSSMAN, MARCY L., and FROST, THOMAS T.:** Secondary vascular changes in the lungs (ab), Feb., 281
- See **JACOBSON, GEORGE**
- SUSSMAN, RALPH M., and MILLER, JAY:** Iodide "mumps" after intravenous urography (ab), June, 905
- SUTOW, WATARU W., and PRYDE, ARTHUR W.:** Incidence of spina bifida occulta in relation to age (ab), Jan., 139
- SUTTON, DAVID.** See **EASTCOTT, H. H. G.**
- SUTTON, H.** See **CONGDON, C. C.**
- SWALLOWING.** See Deglutition
- SWENDESD, MARIAN E.** See **HALSTED, JAMES A.**
- SWIERENGA, J.** See **VERSTEEGH, R. M.**
- SWIFT, MARGUERITE N., and TAKETA, S. TOM:** Modification of acute intestinal radiation syndrome through shielding (ab), April, 634
- TAKETA, S. TOM, and BOND, VICTOR P.:** Efficacy of hematopoietic protective procedures in rats x-irradiated with intestine shielded (ab), March, 474
- SYCAMORE, LESLIE K.:** Radiologic diagnosis of hiatus hernia (ab), June, 894
- SYMPATHECTOMY**
—roentgenologic aspects of retropleural hematomas following sympathectomy, Saul Scheff, Wallace W. Bednarz and George Levene, Feb., 224
- SYNCHROTRON; SYNCHROCYCLOTRON.** See Protons; Roentgen Rays, protection against
- SYPHILIS.** See Aneurysm, aortic
- SYRINGE**
—improved syringe for angiography (ab), B. Selverstone et al., March, 461
- SYVERTON, JEROME T.** See **BOUCHER, NORMAN E., Jr.**
- T**
- TÄNZER, A.:** Basilar impression (ab), March, 435
- TAKETA, S. TOM.** See **SWIFT, MARGUERITE N.**
- TALUS.** See Ankle
- TARAZI, A. K.** See **MARGOLIS, G.**
- TARSUS**
—bilateral osteochondritis of middle cuneiform bone; case, Ivor P. Smyth, April, 575
—dysplasia epiphysialis hemimelica (tarso-epiphysal aclasia), Theodore E. Keats, April, 558
- TAVERAS, JUAN M.** See **MOUNT, LESTER A.**
- See **POSER, CHARLES M.**
- TAYEBI, HOOSHANG, and SILVERMAN, FREDERIC N.:** Congenital defect of the bony orbit and pulsating exophthalmos (ab), June, 886
- TAYLOR, J. G.** See **SHAW, E. G.**
- TAYLOR, LAURISTON S.:** Radiation protection for the general practitioner (ab), June, 916
- TAYLOR, LAWRENCE:** Cortisone versus x-ray in treatment of subacute thyroiditis: a report of 4 cases (ab), April, 622
- TAYLOR, WILLIAM F.** See **KONECCI, EUGENE B.**
- TEACHING.** See Education
- TECHNICIANS**
—International Convention of X-Ray Technicians (Second), March, 426
- TEETH**
—device for localization of dental remnants in edentulous regions, Morris Owen, April, 582
- TEICHERT, G.:** Accessory bones of the intervertebral disks and spondylitis deformans (ab), Feb., 296
- TELEFILMPLANIGRAPHY.** See Body Section Roentgenography
- TELEPAQUE.** See Biliary Tract; Gallbladder
- TEMKIN, EUGENE.** See **ISAAC, FRANK**
- TEMPERATURE**
—influence of temperature stress on uptake of P^{32} in rat (ab), John A. Sealander, Jr., June, 918
—temperature dependence of bacterial inactivation by x-rays (ab), C. E. Stapleton and C. W. Edington, June, 918
- TEMPORAL BONE**
—radiological anatomy (ab), Máximo García Castañeda et al., June, 885
- TENDONS**
—arthrography of shoulder as diagnostic aid in tendon injuries (ab), Graham A. Kernwein et al., Feb., 297
- TENNISON, CHARLES W.** See **PRIDGEN, JAMES E.**
- TEPLICK, J. GEORGE:** Duodenal loop changes in posterior penetration of duodenal ulcer (ab), March, 447
- TERIDAX.** See Biliary Tract; Gallbladder
- TER-POGOSSIAN, MICHEL:** Monochromatic roentgen rays in contrast media roentgenography (ab), Feb., 301
- TESLUCK, H.** See **EYLER, WILLIAM R.**
- TESTES**
—on direct and indirect effects of x-rays on testis of rat (ab), Henry I. Kohn, Feb., 314
- tumors**
—management of malignant tumors at Radiumhemmet in Stockholm; 247 patients (ab), Gustaf Notter, April, 621
- THEANDER, GEORG:** Cholegraphic signs of acute biliary stasis (ab), April, 610
On the visualization of the bile ducts in cholegraphy (ab), March, 450
On the visualization of the renal pelves in cholegraphy (ab), Feb., 295
- THIELEN, ARTHUR J.** See **SHARF, ANDREW G.**
- THIGH**
—arterial disease as cause of pain in buttock and thigh (ab), George Bonney, June, 893
- THIOCYANATES**
—effect of total-body x-irradiation on plasma volume, red cell volume, blood volume and thiocyanate space in normal and splenectomized rats (ab), Kee-Chang Huang and James H. Bondurant, April, 635
- THODE, H. G.** See **JAIME, C. H.**
- THOMAS, A. ROBINSON:** Technique of sialography (ab), Feb., 279
- THOMAS, CHARLES I., and KROHMER, JACK:** A transilluminator for use with the curved Geiger counter. An aid to localization of posterior intraocular tumors (ab), April, 630
- KROHMER, JACK S., MacINTYRE, WILLIAM J., and BOVINGTON, MARY:** Small end-window and angle-window Geiger counters. Measurement of radioactivity in intraocular tumors following injection of radioactive phosphorus (ab), April, 630
- THOMAS, COLIN G., Jr.:** Lymphatic dissemination of radiogold in the presence of lymph node metastases (ab), May, 788
- THOMAS, JOHN R.** See **WIGBY, PALMER E.**
- THOMLEY, MILES W., ORR, LOUIS M., and CAMPBELL, JAMES L.:** Treatment of inoperable prostatic carcinoma with radioactive gold (ab), April, 629
- THOMPSON, WILLIAM H.** See **FINDLEY, JOHN W., Jr.**
- THOMPSON, FRANK B.:** Residual stone in the biliary ducts (ab), May, 774
- THORACIC DUCT**
—importance of thoracic duct in spread of malignant disease (ab), Alejandro Celis et al., Jan., 126
- THORAEUS, R.:** Monitoring filters in roentgen therapy (ab), March, 466
Periodic control of the function and constancy of ionization chamber dose meters (ab), April, 623
- THORAX**
See also Bronchi; Heart; Lungs; Mediastinum; Ribs; etc.
—relation of pectus excavatum to heart disease (ab), Fred W. Wachtel et al., May, 769
- mycosis.** See Blastomycosis
- roentgenography**
—changes in endothoracic organs due to positioning of patient (ab), H. Hackenthal and W. Rube, March, 436
—lordotic position in fluoroscopy and roentgenography (ab), Berkeley Zinn and James Monroe, Feb., 280
—modification of routine lateral view to permit visualization of superior mediastinum (ab), Walter Lentino et al., Feb., 285
—radiologic evaluation of chest lesions in children (ab), Samuel B. Chapman, April, 603
—teaching of chest radiology to medical students (ab), Charles T. Dotter, April, 603
- tumors.** See also Thyroid, aberrant
—angiocardiology in intrathoracic tumors with particular reference to question of operability (ab), Per Amundsen and Edwin Sørensen, Jan., 126
—radiologic picture of intrathoracic tumors of sympathetic nervous system (ab), Leonardo Papagni, March, 439
- THORIUM**
—analysis of mixtures of radioactive isotopes by γ -ray measurements. Application of method to Ac^{227} , Th^{232} , and Ra^{226} (ab), D. S. Anthony et al., March, 473
—case of accidental puncture contaminated with Th^{232} ; studies on elimination and residual body activity, P. F. Gustafson, L. D. Marinelli and E. A. Hathaway, March, 358
—dose to trachea and bronchi from decay products of radon and thoron (ab), A. C. Chamberlain and K. D. Dyson, April, 633

THORIUM—cont.**dioxide**

- atrophy within brain stem area following injection of Thorotrast into vertebral artery; case (ab), Tormod Hauge, June, 883
- danger of cancer from Thorotrast as diagnostic medium (ab), Earl Budin and J. Gershon-Cohen, April, 632
- granuloma of neck following Thorotrast angiography (ab), Laurence F. Levy, March, 436
- hepatic duct carcinoma 17 years after injection of thorium dioxide (ab), James C. Roberts, Jr. and Kenneth E. Carlson, May, 791

THORN, P. A., BROOKES, V. S., and WATERHOUSE, J. A. H.: Peptic ulcer, partial gastrectomy, and pulmonary tuberculosis (ab), Jan., 124

THORON. See Thorium

THOROTRAST. See Thorium dioxide

THORSON, THEODORE A. See BROWN, DAVID B.

THROMBOSIS

- temporary thrombotic state. Application of this concept to therapy of recurrent thrombo-embolism, with bacteriologic and roentgenologic considerations in differential diagnosis of pulmonary infarction and pneumonia (ab), Stanford Wessler et al, Jan., 130

cardiac

- angiocardiographic diagnosis of left atrial thrombosis (ab), Louis A. Soloff and Jacob Zatzuchni, May, 767

carotid

- carotid artery occlusion (ab), J. E. Webster et al, May, 756
- of internal carotid artery (ab), B. J. Shapiro and E. S. Simor, Jan., 130
- role of atlantoid compression in etiology of internal carotid thrombosis (ab), Edwin Boldrey et al, Jan., 121

mesenteric

- fatality following abdominal arteriography (ab), H. R. Roby and J. W. McKay, Jan., 131

THURSTON, CONRAD G. See HARPER, PAUL V.

THYMUS

- comparative activity of isologous vs. homologous or heterologous mouse bone marrow in promoting regeneration of irradiated mouse thymus (ab), Barbara B. Hirsch et al, May, 795
- influence of x-ray on oxygen consumption of spleen and thymus glands of rats (ab), Maurice F. Sullivan and Kenneth P. DuBois, Feb., 314
- radiologist facing evident and latent thymic hypertrophy (ab), Giovanni F. Gardini and Roberto Betti, June, 910

cancer

- co-occurrence of large leiomyoma of esophagus and squamous-cell carcinoma of thymus; case, with roentgenologic, pathologic and clinical discussion (ab), Howard A. Frank et al, May, 772

cysts

- branchiogenic intrathoracic mediastino-thymic cyst (ab), Z. V. Skokan and J. Stolz, May, 767

tumors

- indirect induction of lymphomas in irradiated mice. I. Tumor incidence and morphology in mice bearing non-irradiated thymic grafts (ab), Henry S. Kaplan et al, May, 794
- indirect induction of lymphomas in irradiated mice. II. Factor of irradiation of host (ab), Henry S. Kaplan et al, May, 794
- indirect induction of lymphomas in irradiated mice. III. Role of thymic graft (ab), William H. Carnes et al, May, 794
- indirect induction of lymphomas in irradiated mice. IV. Genetic evidence of origin of tumor cells from thymic grafts (ab), Henry S. Kaplan et al, May, 795

THYROID

- congenital goiter, W. William Nagle, John W. Hope and Alfred M. Bongiovanni, April, 526
- determination of radioiodine uptake in thyroids by 2 methods (ab), Egilda DeAmicis and Earle W. Williamson, June, 911
- iodine-131 beta particle dosage in small animals, Patricia W. Durbin, James S. Robertson and Joseph G. Hamilton, Jan., 103
- some applications of isotope dilution techniques (ab), Rosalyn S. Yalow and Solomon A. Berson, April, 624
- technical considerations in I^{131} tracer studies (ab), Robert E. Beck et al, June, 911
- two ways to estimate thyroid dose from radioiodine in fallout (ab), Gordon M. Dunning, March, 468
- uptake of radioiodine by thyroid cells using nuclear emulsion (ab), Adrian G. Basser, April, 627

aberrant

- lingual goiter treated with radioactive iodine (ab), J. Einhorn and L.-G. Larsson, March, 467
- radiologic study of intrathoracic goiter with axial transverse stratigraphy (ab), A. Santagada and M. Piazzi, Jan., 127

cancer

- cancer (ab), Donald E. Ross, June, 912
- cancer of thyroid and irradiation (ab), Erich M. Uhlmann, April, 632
- cancer, with metastases to lungs. Condition shown by scintigram in absence of definite x-ray findings (ab), Boris Catz and Paul Starr, Jan., 150

- contribution to clinical features, prognosis, and therapy of struma maligna (ab), Eberhard Scherer et al, March, 463
- four cases illustrating use of I^{131} in management of metastatic carcinoma (ab), John P. Storaasli and Donald P. King, April, 628
- osseous metastasis of thyroid origin (ab), A. K. Datta Gupta, Feb., 296
- role of radioiodine in treatment of carcinoma (ab), Gwen Hilton et al, April, 627
- serum I^{131} fractionation in metastatic carcinoma; fate of endogenous radiothyroxine after I^{131} therapy (ab), Manuel Tubis and Franz K. Bauer, Feb., 311
- transplantability of canine thyroid carcinoma through 30 generations in mixed-breed puppies (ab), M. W. Allam et al, June, 918
- treatment (ab), L. Henry Garland, April, 618

diseases

- cortisone versus x-ray in treatment of subacute thyroiditis; 4 cases (ab), Lawrence Taylor, April, 622
- radioiodine uptake in diagnosis of thyroiditis (ab), Elmer C. Paulson, June, 912
- radioiodine uptake test and its application in clinical diagnosis (ab), F. F. Rundle et al, March, 467
- role of radioactive iodine in diagnosis (ab), J. E. Rall, March, 466

function tests

- clinical appraisal of radioiodine tests (ab), William M. McConahey et al, April, 626
- further clinical studies of thyroid and salivary gland function with radioiodine (ab), C. H. Jaimet and H. G. Thode, April, 627
- plasma activity levels in radioiodine tests (ab), H. A. Hughes and R. M. Miller, Jan., 150
- salivary and thyroidal radioiodide clearances of plasma in various states of thyroid function (ab), Karl Fellingner et al, Feb., 309
- study of uptake of I^{131} by thyroid of premature infants (ab), Edgar E. Martner et al, Feb., 309

hyperthyroidism

- acute myeloid leukemia after radioactive iodine therapy (ab), John D. Abbott et al, April, 628
- determination of protein-bound I^{131} with anion exchange resin column (ab), Theodore Fields et al, March, 469
- modern treatment of thyrotoxicosis (ab), George J. Hamwi and Robert F. Goldberg, Feb., 311
- physiologic concepts in diagnosis and treatment of Graves' disease (ab), Brown M. Dobyns, March, 467
- pneumo-thyroid: new procedure for determining mass of thyroid gland for radioiodine treatment of hyperthyroidism (ab), Victor H. Franco and Mario G. Quina, June, 912
- treated with radioiodine; 7-year experience (ab), William H. Beierwaltes and Philip C. Johnson, Feb., 310

hypothyroidism

- metabolism of iodotyrosines. II. Metabolism of mono- and di-iodotyrosine in certain patients with familial goiter (ab), John B. Stanbury et al, June, 912

THYROIDITIS. See Thyroid, diseases

THYROTROXICOSIS. See Thyroid, hyperthyroidism

THYROXINE

- serum I^{131} fractionation in metastatic carcinoma of thyroid; fate of endogenous radiothyroxine after I^{131} therapy (ab), Manuel Tubis and Franz K. Bauer, Feb., 311

TIBIA

- diagnostic and therapeutic obstacles encountered in tibial plateau fractures (ab), Julius S. Neviasser and Sanford H. Eisenberg, April, 613

TIMED-DISINTEGRATION CAPSULES. See Barium

TIN

- colloidal stannic oxide; animal studies on new hepatolienographic agent, Harry W. Fischer, April, 488

TITTLE, C. ROBERT. See MITCHELL, ROBERT E., Jr.

TOCHILIN, E., ROSS, S. W., SHUMWAY, B. W., KOHLER, G. D., and GOLDEN, R.: Cyclotron neutron and gamma dosimetry for animal irradiation studies (ab), Feb., 316

TODD, EDWIN M. See GARDNER, W. JAMES

TOMOGRAPHY. See Body-Section Roentgenography

TONGUE

- lingual goiter treated with radioactive iodine (ab), J. Einhorn and L.-G. Larsson, March, 467

CANCER

- carcinoma; treatment and results without radical surgery (ab), Frank C. Marchetta and Walter L. Mattick, June, 907

TOONE, ELAM C., Jr., and KELLY, JOHN: Joint and bone disease due to mycotic infection (ab), Jan., 138

TORRETTA, A. See BELLINI, B.

TOXINS. See Antitoxins

TRACHEA

- dose to trachea and bronchi from decay products of radon and thoron (ab), A. C. Chamberlain and E. D. Dyson, April, 633
- note on congenital laryngeal stridor (due to tracheomalacia) (ab), T. G. Wilson, April, 601
- roentgen demonstration of movements of ciliated epithelium of trachea: experiments on isolated tracheas of slaughtered animals (ab), H. Birzle, March, 436

stistula. See Fistula

TRANSFUSIONS. See Blood, transfusions

TRANSTER, F. W. See GREENE, D.

- TRAUMA.** See Abdomen; Bones; Brain; Spine; Viscera
- TRETBAR, H. A.** See **STRITTMATTER, W. C.**
- TRIBUNO, C.** See **BELLION, B.**
- TRICUSPID VALVE**
—combined tricuspid and pulmonary atresia with juxtaposition of auricles (ab), A. M. Stewart and A. Wynn-Williams, April, 605
—Ebstein's disease (ab), James W. Brown et al, Jan., 129
- TRIO PAC.** See **Pyelography**
- TRIOQUETRAL BONE.** See **Wrist**
- TRISTAN, THEODORE A., RAVENTOS, ANTOLIN, and CHAMBERLAIN, RICHARD H.:** Disseminated histiocytosis X (Letterer-Siwe's disease) treated unsuccessfully with radioactive colloidal gold (Au^{198}). A case report (ab), June, 913
- TRITIUM**
—theoretic considerations of radiation dose from discrete tritium sources, J. S. Robertson and W. L. Hughes, Jan., 102
- TROMBKA, J. I.** See **OKAWA, CHIYEKO**
- TROUT, E. DALE:** The use of electron beams in industrial processes, May, 708
- TRÜBESTEIN, HERMANN:** The differentiated histologic findings of lymphogranulomatosis as basis of therapeutic success (ab), March, 465
- TUBERCULOSIS**
See also Fallopian Tubes; Spine; Tuberculosis, Pulmonary
—calcification of regional lymph nodes following BCG vaccination (ab), Samuel C. Stein and Martin J. Sokoloff, Jan., 124
—in infants and children. Review (ab), John S. Chapman, Jan., 123
—postprimary intrathoracic tuberculosis in childhood, with special reference to its sequelae (ab), R. J. Derham, June, 888
—tuberculous coin lesions—roentgenological symptom (observations in children and adolescents) (ab), H.-D. Renowanz, March, 438
- TUBERCULOSIS, PULMONARY**
—giant air cyst(s) as sequela of pulmonary tuberculosis (ab), John L. Shek et al, May, 766
—peptic ulcer, partial gastrectomy, and pulmonary tuberculosis (ab), P. A. Thorn et al, Jan., 124
- cancer and tuberculosis**
—bronchogenic carcinoma and pulmonary tuberculosis; problems in diagnosis with special reference to antituberculous chemotherapy (ab), Herman Weissman, June, 888
—primary pulmonary carcinoma associated with active pulmonary tuberculosis (ab), F. Bender, June, 888
- cavitation in**
—study of tuberculosis cavities by contrast media and other methods (ab), Oren A. Beatty, March, 437
- in children.** See **Tuberculosis**
- mass roentgenologic surveys**
—aspects of mass surveys in New South Wales (ab), Charles Rubinstein, Feb., 283
—mass surveys (ab), A. H. McNaughton, Feb., 282
—mass surveys (ab), P. S. Woodruff, Feb., 282
—static mass radiography in London borough (ab), G. Z. Brett et al, Jan., 125
—tuberculosis studies in Muscogee County, Georgia. V. Tuberculosis mortality during 7 years after community-wide survey (ab), George W. Comstock, Jan., 124
- roentgenography.** See also **Tuberculosis, in children; other subheads under Tuberculosis, Pulmonary**
—correlated bronchographic and histopathologic study of bronchial disease in 216 tuberculous patients (ab), Raymond F. Corpe and Eugene C. Hwa, March, 437
—factors influencing radiological attack rate of progressive massive fibrosis (ab), A. L. Cochran and W. E. Miall, March, 438
—selective angiopneumography and correlative study of bronchography and histopathologic findings in tuberculosis of the thorax (ab), Raúl Cicero et al, Jan., 124
- TUBIS, MANUEL, and BAUER, FRANZ K.:** Serum I^{131} fractionation in metastatic carcinoma of the thyroid. The fate of endogenous radiothyroxine after I^{131} therapy (ab), Feb., 311
- TUCHMAN, H.** See **ROWE, GEORGE G.**
- TUCKER, ARTHUR S.:** Myelography of complete spinal obstruction (ab), June, 900
- TUDWAY, ROBERT C.:** Some radiosensitive bone tumours (ab), Feb., 302
- TUGGLO, ALLAN.** See **YOUNGBLOOD, VERNON H.**
- TULAREMIA**
—pleuropulmonary tularemia: its roentgen manifestations, John M. Dennis and Robert P. Boudreau, Jan., 25
- TULLIS, JOHN L.** See **FURTH, JACOB**
- TUMORS**
See also **Cancer; Sarcoma;** and under names of organs and regions
adenoma. See **Bronchi; Lungs, cancer; Parathyroid**
- angioma**
—cerebral angiography in encephalo-trigeminal angiomatosis, Charles M. Poser and Juan M. Taveras, March, 327
—hemangioma of small intestine, Seymour Ochsner and Rawlick M. Penick, Jr., June, 845
—posterior mediastinal hemangioma, S. B. Feinberg, Jan., 90
—treatment of hemangiomas with strontium-90 beta-ray applicator, David M. Sklaroff, Jan., 87
—tumor of bone of vascular origin; anatomical-radiological considerations of primary hemangioma of skull (ab), Giovanni Baldini and Luigi Ferri, April, 611
—unusual case of Lindau's disease. Cystic disease of kidneys and pancreas with renal and cerebellar tumors (hemangioblastoma) (ab), Frank Isaac et al, March, 460
- argentaffinoma**
—malignant argentaffinoma associated with cardiovascular abnormalities (ab), W. R. Eyster et al, Jan., 129
- cholesteatoma**
—concerning roentgen diagnosis of intracranial dermoids (so-called cholesteatoma) (ab), H.-E. Schulze, Feb., 278
- chondroma**
—juxtacortical chondroma (ab), Henry L. Jaffe, April, 610
- experimental**
—effect of peritumoral tissue infiltration with radioactive yttrium on growth and spread of malignant cells (ab), Horace Goldie and Harold D. West, May, 790
—effect of radiophosphorus and cortisone on transplanted mammary adenocarcinomas in susceptible and resistant mice (ab), Norman E. Boucher, Jr., et al, May, 789
—effect of single doses of roentgen radiation on experimentally induced gliomas: with critical review of effects of roentgen radiation on gliomas in man (ab), Martin G. Netsky et al, June, 917
—investigation into experimental production of cancer by local beta irradiation (ab), G. Schubert et al, May, 794
—relation of tumor size to radioresistance, Charles M. Nice, Jr., April, 555
- fibroma**
—non-osteogenic fibroma of bone (fibrous metaphyseal defect) (ab), Roy H. Maudsley and Alfred G. Stansfeld, June, 898
- giant-cell**
—radiotherapy of xanthomatous giant-cell tumors (ab), Sven Hultberg and V. Belloch Zimmermann, June, 909
- glioblastoma.** See **Brain, tumors**
- glioma.** See **Brain, tumors**
- granulosa-cell.** See **Ovary, tumors**
- hamartoma**
—massive cystic pulmonary hamartosis; 2 cases (ab), Robert C. Jackson et al, Feb., 282
- hemangioma.** See **Tumors, angioma**
- leiomyoma.** See **Tumors, myoma**
- lipoma**
—multiple lipomas of ileum (ab), John W. Findley, Jr., and William H. Thompson, Jan., 133
- lymphogranuloma.** See **Hodgkin's Disease**
- lymphoma**
—indirect induction of lymphomas in irradiated mice. I. Tumor incidence and morphology in mice bearing non-irradiated thymic grafts (ab), Henry S. Kaplan et al, May, 794
—indirect induction of lymphomas in irradiated mice. II. Factor of irradiation of host (ab), Henry S. Kaplan et al, May, 794
—indirect induction of lymphomas in irradiated mice. III. Role of thymic graft (ab), William H. Carnes et al, May, 794
—indirect induction of lymphomas in irradiated mice. IV. Genetic evidence of origin of tumor cells from thymic grafts (ab), Henry S. Kaplan et al, May, 795
—lymph node-fever relationship in lymphoma (ed), Don E. Matthieson, May, 739
—therapy of malignant lymphomas. I. Study of 116 cases. II. Review (ab), Charles A. Hall and Kenneth B. Olson, Jan., 147
- meningioma.** See **Meninges, tumors**
- mesothelioma**
—treatment of peritoneal and pleural mesothelioma and metastatic malignancy with radioactive colloidal gold (ab), F. M. Lyle and Philip S. King, April, 628
- metastases.** See **Cancer, metastases; Tumors, mesothelioma**
- myeloma.** See **Bones, marrow**
- myoma**
—co-occurrence of large leiomyoma of esophagus and squamous-cell carcinoma of thymus; case, with roentgenologic, pathologic and clinical discussion (ab), Howard A. Frank et al, May, 772
—leiomyoma of esophagus (ab), Joseph Schlager et al, March, 446
- neurinoma**
—segmental radiography of internal auditory canal in neurinomas of eighth nerve (ab), H. Fischgold et al, May, 761
- neuroblastomas**
—neuroblastomas in infancy and childhood; review of 10 years experience (ab), C. W. Reiquam et al, April, 621
—protection of ovaries from radiation (for neuroblastoma) (ab), Richard Batten and D. E. Meredith Brown, May, 791
—radiation therapy, William B. Seaman and Mark D. Eagleton, Jan., 1
- osteoma**
—natural history of osteoid osteoma of spine; review of literature and report of 3 cases (ab), Alvina O. Sabanas et al, June, 901
—osteoid osteoma of ischium with hip joint complications (ab), F. G. Stuart, April, 613
- pheochromocytoma**
—danger of aortography in localization of pheochromocytoma (ab), Nathan J. Saltz et al, May, 785

TUMORS—cont.

- pinealoma.** See Pineal Gland polyp
- clinical and radiological study of choanal polyp (ab), D. F. Reynolds and H. J. Groves, Feb., 279
- Wilms'.** See Kidneys, tumors
- TURIAF, J., MARLAND, P., and JEANJEAN, Y.:** Chronic pulmonary infiltration with eosinophilia in the asthmatic. (Five personal observations, including one with histopathologic analysis) (ab), Feb., 283
- See **MARLAND, P.**
- TURNBULL, A. C.:** Radiation menopause or hysterectomy. Part II. Mortality, morbidity, and subsequent pelvic cancer (ab), Feb., 305
- TURNER, ELIZABETH K.:** The Ellis-Creveld syndrome: report of a case (ab), Jan., 139
- TWINS**
- coxa plana in dizygotic male twins (ab), Paul S. Derian, May, 783
- TYOR, MALCOLM P., and ELDRIDGE, JAMES S.:** A comparison of the metabolism of rubidium 86 and potassium 42 following simultaneous injection into man (ab), June, 913
- TYROSINES**
- metabolism of iodotyrosines. II. Metabolism of mono- and di-iodotyrosine in certain patients with familial goiter (ab), John B. Stanbury et al, June, 912

U

- UEBERSCHÄR, KARL-HEINZ.** See **DIRKNER, RUDOLPH**
- UHLMANN, ERICH M.:** Cancer of the thyroid and irradiation (ab), April, 632
- UHLMANN, G.** See **SCHUBERT, G.**
- ULCERS**
- See also Intestines; Peptic Ulcer; Varicose Veins
- bone changes in tropical ulcer (ab), J. Scott Brown and J. H. Middlemiss, Feb., 296
- ULNA**
- cyst-like structures in proximal end of ulna: anatomic and roentgenological appearance and interpretation (ab), G. Iannaccone and M. Barilla, March, 455
- UNDEM, DALE.** See **PIRKEY, EVERETT L.**
- UNDULANT FEVER**
- chronic localized pulmonary brucellosis (ab), Lyle A. Weed et al, May, 765
- meningoencephalitis due to *Brucella abortus* (ab), P. Ebeling and E. Graeme Robertson, April, 600
- UPTON, A. C., CONTE, F. P., HURST, G. S., and MILLS, W. A.:** Relative biological effectiveness of fast neutrons, x-rays, and γ -rays for acute lethality in mice (ab), Feb., 316
- UREMIA**
- renal osteodystrophy in adults (ab), I. McLean Baird and F. Lees, May, 779
- URETERS**
- See also Pyelography
- obstructed ureteropelvic junction, Robert Lich, Jr., March, 337
- dilatation**
- megalo-ureter (ab), Evan L. Lewis and Richard W. Cletso-way, Feb., 301
- fistula.** See **Fistula inflammation**
- cystitis and ureteritis emphysematosa, C. Soteropoulos, E. Kawashima and John H. Gilmore, June, 866
- ureteritis cystica and pyelitis cystica; review of cases and roentgenologic criteria, Bernard S. Loitman and Harold Chiat, March, 345
- roentgenography**
- roentgenographic behavior of ureter (ab), Hunter B. Frisch-korn, Jr., March, 458
- significance of ureteral studies in surgery of colon and rectum (ab), H. E. Bacon and L. McCrea, March, 458

URETHRA

- cancer**
- treatment of tumors (ab), R. H. Flocks, Jan., 146
- fistula.** See **Fistula roentgenography**
- cystourethrography: clinical experience with newer contrast media (ab), Joseph J. Kaufman and Murray Russell, March, 458
- positive pressure urethrography: new diagnostic method (ab), Hugh J. Davis and Louis G. Cian, Feb., 301
- simple instrument for urethroscopy and fistulography in adults and children (ab), Åke Gullmo, April, 616
- urethrocytographic classification of prostatism (ab), M. L. Prodyn and S. A. Robins, March, 459
- urethrocytography in differential diagnosis of prostatic cancer (ab), K. J. Oravisto and S. Schaumann, April, 615
- tumors**
- treatment (ab), R. H. Flocks, Jan., 146
- URETHROCYSTOGRAPHY.** See Urethra
- URETHROGRAPHY.** See Urethra
- URINARY TRACT.** See Bladder; Kidneys; Pyelography
- URINE**
- plasma, tissue and urinary radioactivity after oral administration of ^{54}Co -labeled vitamin B_{12} (ab), C. C. Booth and D. L. Mollin, May, 789

- studies in urinary excretion of vitamin $\text{B}_{12}\text{Co}^{60}$ in pernicious anemia for determining effective dosage of intrinsic factor concentrates (ab), William R. Best et al, March, 471
- time pattern of vitamin $\text{B}_{12}\text{Co}^{60}$ urinary excretion in man after oral administration and parenteral "flushing" (ab), William R. Best et al, March, 472
- urinary excretion and plasma levels of free ninhydrin reactive compounds in x-irradiated rats (ab), R. E. Kay et al, May, 796
- UROGRAPHY.** See Pyelography
- UROKON.** See Arteries, renal; Cardiovascular System; Eyes; Iodine and Iodine Compounds; Pyelography
- UROLOGY.** See Kidneys; Ureters; etc.
- URSO, P., Jr.** See **CONGDON, C. C.**
- URTICARIA**
- radiologic and pathologic bone changes associated with urticaria pigmentosa; case (ab), Ernest Stark et al, June, 899

UTERUS

- abnormalities**
- soft-tissue placentography in diagnosis of bicornuate uterus, Robert B. Engle, George Jacobson, and Eleanor R. Fraser, March, 408
- cancer**
- bone lesions secondary to cancer of uterus (ab), J. Roussel et al, March, 453
- cervical cancer: opportunity (weekly radium applications) (ab), Herbert E. Schmitz, April, 619
- cervical carcinoma: action of x-rays on mammalian cells (ab), Theodore T. Puck and Philip I. Marcus, March, 475
- cervical carcinoma associated with pregnancy (ab), Glen E. Hayden, Feb., 304
- cervical carcinoma: 4 years of cooperation of gynecologist and radiotherapist (ab), John A. Isherwood et al, Feb., 304
- cervical carcinoma: intensive divided-dose irradiation therapy: rationale and late results (ab), Robert E. Fricke and David G. Decker, Feb., 304
- cervical carcinoma: phosphamidase in cells of vaginal smears before and after radiotherapy (ab), Peter Sepp, Jan., 146
- cervical carcinoma: surgery as adjunct to irradiation: preliminary report (ab), Edward J. Crawford, Jr. et al, April, 620
- cervical carcinoma: 10-year study with comparison of results of irradiation and radical surgery, Ralph S. Clayton, Sr., Jan., 74
- dose decrease in bladder and rectum in gynecologic radium treatments (ab), August Verhagen, Jan., 146
- importance of intestinal flora in radiation treatment of gynecological carcinomata (ab), J. Breiter and W. Roth, April, 621
- moving field therapy of gynecological tumors in pelvis (ab), H.-J. Maurer, June, 909
- radiation menopause or hysterectomy. Part II. Mortality, morbidity, and subsequent cancer (ab), A. C. Turnbull, Feb., 305
- superiority of surgical treatment of endometrial carcinoma (ab), J. Chandler Smith, Feb., 304
- study of 531 cases of endometrial carcinoma (ab), John H. Randall and William B. Goddard, June, 909
- treatment of choice in cancer of corpus (ab), John B. Graham, April, 620
- treatment of endometrial adenocarcinoma. Study of 381 cases at New York Hospital. Preliminary report (ab), Carl T. Javert and R. Gordon Douglas, Jan., 145
- vaginal metastases following treatment of endometrial carcinoma (ab), Richard W. Stander, Feb., 304
- cervix.** See Uterus, cancer
- hemorrhage**
- radiation menopause or hysterectomy. Part II. Mortality, morbidity, and subsequent pelvic cancer (ab), A. C. Turnbull, Feb., 305
- roentgenography**
- hysterothography in diagnosis of dead and retained human ovum (ab), Juan C. Ahumada et al, April, 614

V**VAGINA**

- atresia of vagina in infancy (ab), Robert H. Whittlesey et al, June, 902
- cancer**
- primary cancer: irradiation management and end-results, Walter T. Murphy, Feb., 157
- vaginal metastases following treatment of endometrial carcinoma (ab), Richard W. Stander, Feb., 304
- tumors**
- spindle-cell sarcoma; case treated by radium implant (ab), Paul Strickland and H. C. Perry, Feb., 305
- van BUCHEM, F. S. P.:** Dilatation of the pulmonary artery in pulmonary stenosis (ab), March, 442
- Van BUSKIRK, FREDERICK W.** See **STARK, ERNEST**
- van CANEGHEM, PIERRE, and SCHIRREN, CARL G.:** Animal experiments on radiosensitivity of growing bone (ab), May, 796
- van CREVELD-ELLIS SYNDROME.** See Ectodermal Defect
- VAN de GRAAFF ACCELERATOR; GENERATOR.** See Electrons; Roentgen Therapy

- VARADARAJAN, M. G.:** Case of bilateral parotid calculi (ab), April, 600
- VARCO, RICHARD L.** See **GOTT, VINCENT L.**
- VARICOSE VEINS**
—lesions of bones of leg in course of varicose ulcers (ab), A. Poirault, May, 783
- VEINS**
See also Aneurysm; Portal Vein; Varicose Veins; Venae Cavae
brachiocephalic
—corner positioning for visualization of brachiocephalic vessels, Israel Steinberg and Bernard K. Ryan, Feb., 242
cerebral. See Brain, blood supply
istula. See Fistula
innominate. See Veins, brachiocephalic
pulmonary. See also Fistula, arteriovenous
—anomalous pulmonary venous drainage (ab), John B. Hickie et al, May, 769
—mitral stenosis associated with anomalous pulmonary venous drainage into left superior vena cava (ab), M. M. Zion, March, 441
—posteroanterior chest roentgenogram in two types of anomalous pulmonary venous connection (ab), André J. Bruwer, May, 770
—total anomalous pulmonary return; analysis of 30 cases (ab), Vincent L. Gott et al, Feb., 288
roentgenography. See also Extremities, blood supply; Portal Vein; Venae Cavae; other subheads under Veins
—dangers and technic of osteomyelography and transosseous venography (ab), H. J. Sisse, June, 906
- VENAE CAVAE**
—congenital aneurysm of superior vena cava (ab), G. H. Lawrence and T. H. Burford, Feb., 287
—mitral stenosis associated with anomalous pulmonary venous drainage into left superior vena cava (ab), M. M. Zion, March, 441
—partial obstruction of inferior vena cava by herniation of liver through foramen of Morgagni; case, David Rosenblum, Arnold Nussbaum and Solomon Schwartz, March, 390
—roentgen examination of inferior vena cava in retroperitoneal expanding processes (ab), C. G. Helander and Å. Lindbom, Feb., 288
—venography in superior vena caval obstruction, Granville W. Hudson, April, 499
- VENTRICULOGRAPHY.** See Brain, roentgenography
- VERBIEST, H.:** Contribution to the methods of filling the posterior fossa and the adjoining cervical subarachnoid space with small quantities of air (ab), June, 883
- and **FEDDEMA, J.:** Cerebral cine-angiography with the image intensifier (ab), June, 907
- VERHAGEN, AUGUST:** Dose decrease in bladder and rectum in gynecologic radium treatments (ab), Jan., 146
- VERSTEGH, R. M., and SWIERENGA, J.:** Role of sinusitis in bronchiectasis (ab), June, 891
- VERTEBRAE.** See Spine
- VETTER, HERBERT.** See **FELLINGER, KARL**
- VIALLET, P., SENDRA, L., CHEVROT, L., COMBE, P., DESCUN, P., and AUBRY, P.:** New method of total simultaneous cerebral angiography by rapid intravenous injection (ab), May, 755
- See **PHELINE, CH.**
- et al.: Simple angiographic method for the study of the greater circulation. "Enlarged" angiocardipneumography (ab), March, 443
- VIETEN, HEINZ:** Cerebral serial angiography on 70 mm. film size (ab), June, 882
- VINSON-PLUMMER SYNDROME.** See Deglutition, disorders
- VIRDEN, C. EDGAR,** President of Radiological Society of North America (ed), Ira H. Lockwood, Feb., 262
- VISCERA**
See also Abdomen; under names of viscera
—changes in endothoracic organs due to positioning of patient (ab), H. Hackenthal and W. Rube, March, 436
—trauma to abdominal and retroperitoneal viscera as it concerns radiologist (ab), J. Cash King, April, 617
- transposition**
—Kartagener's syndrome; case (ab), E. Finkler, March, 460
—Kartagener's syndrome in newborn infant (ab), Samuel J. Nichamin, May, 766
—Kartagener's triad (situs inversus, bronchiectasis, and sinusitis); case (ab), David L. Deutsch, June, 891
- VISCODOL.** See Bronchi, roentgenography
- VITAL CAPACITY**
—lung compartment determination (ab), John C. Kovach et al, Feb., 280
—roentgenologic evaluation of pulmonary function; correlation with physiologic studies of ventilation (ab), Robert P. Barden and Julius H. Comroe, Jr., Feb., 280
- VITAMINS**
B
—evaluation of fecal recovery method for determining intestinal absorption of cobalt⁶⁰-labeled vitamin B₁₂ (ab), James A. Halsted et al, May, 790
—plasma, tissue and urinary radioactivity after oral administration of ⁶⁰Co-labeled vitamin B₁₂ (ab), C. C. Booth and D. L. Mollin, May, 789
—studies on urinary excretion of vitamin B₁₂Co⁶⁰ in pernicious anemia for determining effective dosage of intrinsic factor concentrates (ab), William R. Best et al, March, 471
—time pattern of vitamin B₁₂Co⁶⁰ urinary excretion in man after oral administration and parenteral "flushing" (ab), William R. Best et al, March, 472
- VOGEL, HOWARD H., Jr., CLARK, JOHN W., and JORDAN, DONN L.:** Comparative mortality following single whole body exposures of mice to fission neutrons and Co⁶⁰ gamma rays, March, 386
- VOGEL, WILLIAM C.** See **ZIEVE, LESLIE**
- VOMITING**
—some rare causes of vomiting in infancy and childhood (ab), S. P. Rawson, March, 460
- VONDRAŠEK, STANLEY C.** See **PERRY, JOHN F., Jr.**
- VREELAND, HOWARD W.** See **KLIGERMAN, MORTON M.**
- W**
- WACHSMANN, FELIX, and YIANNAKOPOULOS, APOSTOLOS:** Dependence of the latency period of radiobiologic reaction on the size of the dose (ab), May, 793
- WACHTEL, FRED W., RAVITCH, MARK M., and GRISHMAN, ARTHUR:** The relation of pectus excavatum to heart disease (ab), May, 769
- WALD, ARNOLD M.:** Nephrography during routine excretory urography (ab), Jan., 142
- WALK, L.:** Clinical significance of discography (ab), May, 782
- WALKER, PHYLLIS.** See **ISAAC, FRANK**
- WALLER, ROBERT D., and ROBERTS, S. M.:** Cholecystographic visualization of the Rokitsky-Aschoff sinuses: report of a case and review of the literature (ab), April, 609
- WALLWORK, DAVID W.** See **GANEM, EMIL J.**
- WALSTAM, RUNE.** See **LINDELL, BO**
- WALTON, HOWARD, Jr.** See **GRAHN, DOUGLAS**
- WANG, C. C., and ROBBINS, LAURENCE L.:** Roentgenologic diagnosis of ruptured spleen (ab), Jan., 137
- WANGENSTEEN, OWEN H.** See **PERRY, JOHN F., Jr.**
- WANNAGAT, L.:** Does "laparoscopic" splenoportography indicate an advance in the field of medical x-ray diagnosis? A contribution to the early diagnosis of intrahepatic obstruction (ab), March, 451
- WAR**
—roentgenological findings of small intestine in 100 repatriated prisoners of war. Deficiency states and worm infestations (ab), Walter Francke, May, 773
- WARD, GRANT E.** See **WINSTEN, JOSEPH**
- WARD, M. W. P.** See **OSBORNE, G.**
- WARNER, ROBERT S.** See **CHRISTENSEN, WM. R.**
- WARREN, STAFFORD L., and STEIN, JUSTIN J.:** Radiological defense plans in California (ab), Feb., 312
- WASSERBURGER, KARL:** Treatment of Dupuytren's contracture (ab), June, 910
- WATER**
—Monte Carlo calculations on spectrum of scattered radiations produced in water by x-ray beams of interest in radiotherapy, W. R. Bruce and H. E. Johns, Jan., 100
—studies of dose distributions in water for betatron x-rays up to 37 MEV (ab), B. Zentile et al, June, 910
- WATERHOUSE, J. A. H.** See **THORN, P. A.**
- WATERMAN, DAVID H.** See **DOMM, SHELDON E.**
- WATKINS, IVAN.** See **HOECKER, FRANK E.**
- WATSON, J. A.** See **CEMBER, H.**
- WATSON, T. A.:** Supravoltage roentgen therapy in cancer of the lung (ab), Jan., 144
- WATSON, WILLIAM L.** See **CARROLL, ROBERT E.**
- WEBER, DANICA.** See **BAŠIĆ, MARKO**
- WEBER, HARRY M.** See **FERRIS, DEWARD O.**
- WEBSTER, D. H.:** Pulmonary nocardiosis. A review with a report of seven cases (ab), Feb., 285
- WEBSTER, J. E., GURDJIAN, E. S., and MARTIN, F. A.:** Carotid artery occlusion (ab), May, 756
- WEED, LYLE A., SLOSS, PIERCE T., and CLAGETT, O. THERON:** Chronic localized pulmonary brucellosis (ab), May, 765
- WEGELIUS, CARL.** See **BOESEN, IB**
- WEGENER'S GRANULOMATOSIS.** See Granuloma
- WEIGHT**
—analysis of effects of total-body x-irradiation on body weight of white Swiss mice. II. Body-weight changes of male mice as biological dosimeter (ab), William H. Chapman and Edward A. Jerome, April, 633
- WEINBERG, JOSEPH A.** See **JOHNSTON, PAUL W.**
- WEINMAN, E. O.** See **SUPPLEE, HELEN**
- WEINSTEIN, ARVIN B.** See **ROWE, GEORGE G.**
- WEIR, ROYAL A., and LIZAMA, CARLOS:** Operative cholangiography. Survey of 83 cases in 232 cholecystectomies (ab), Feb., 294
- WEISSMAN, HERMAN:** Bronchogenic carcinoma and pulmonary tuberculosis. Problems in diagnosis with special reference to antituberculous chemotherapy (ab), June, 888
- WEISSMAN, IRVING, WORDEN, JAMES P., and CHRISTIE, JAMES M.:** Mediastinal parathyroid carcinoma with metastases. Report of a case and review of the literature, March, 352
- WELDERS.** See Industry and Occupations
- WELLAUER, J., and DEL BUONO, M.:** Experiences with Triopac. A new tri-iodine-containing contrast material, for intravenous urography (ab), May, 785
- WELLENS, P.:** Unusual roentgenologic aspects of pulmonary metastases (ab), Feb., 282

- WELLS, HERSCHEL J. See MACK, ROBERT E.
- WESSLER, STANFORD, COHEN, SIDNEY, and FLEISCHNER, FELIX G.: The temporary thrombotic state. Application of this concept to the therapy of recurrent thrombo-embolism, with bacteriologic and roentgenologic considerations in the differential diagnosis of pulmonary infarction and pneumonia (ab), Jan., 130
- WEST, GEORGE V. See GANEM, EMIL J.
- WEST, HAROLD D. See GOLDIE, HORACE
- WESTERGART, JOHN P. See BAUER, FRANZ K.
- WETHERLEY-MEIN, G., HUTT, M. R. S., LANGMEAD, W. A., and HILL, M. J.: Radioactive iron studies in routine haematological practice (ab), April, 631
- WHITAKER, WILLIAM. See BROWN, JAMES W.
- WHITE, WILFRID F. See BEST, WILLIAM R.
- WHITEHEAD, RICHARD W. See LANIER, RAYMOND R.
- WHITEHOUSE, W. See FRANKSSON, C.
- WHITEHOUSE, WALTER M.: Re-evaluation of fat-free prepratory meal in Telepaque cholecystography (ab), May, 775
- WHITMORE, G. F. See JOHNS, H. E.
- WHITTLESEY, ROBERT H., ATIK, MOHAMMAD, and JONES, JAMES C.: Arteria of the vagina in infancy (ab), June, 902
- WICK, ARNE H. See DRURY, DOUGLAS R.
- WICKBOM, I.: Angiography and pneumography in the diagnosis of slightly space-occupying supratentorial tumours (ab), May, 758
- WIESER, C.: Volumetric findings in the emptying test in non-calculous cholecystopathies (ab), March, 450
- WIGBY, PALMER E., and THOMAS, JOHN R.: Spondylolysis: an autopsy study. Preliminary report, Jan., 94
- WILBUR, KARL M. See BERNHEIM, FREDERICK
- WILDER, ROBERT J., MOSCOVITZ, L., and RAVITCH, MARK M.: Transventricular and aortic angiocardigraphy and physiologic studies in dogs with experimental mitral and aortic insufficiency (ab), May, 771
- WILDERMUTH, ORLISS, and EVANS, JOHN C.: The special problem of cancer of eyelid (ab), June, 908
- WILK, S. P. See WOODRUFF, J. H., Jr.
- WILKS, SYRREL S. See KONECZI, EUGENE B.
- WILLIAMS, A. JUSTIN. See PULLENLOVE, TOM M.
- WILLIAMS, JEROME O. See YOUNGBLOOD, VERNON H.
- WILLIAMS, MARVIN M. D., and CHILDS, DONALD S., Jr.: Diagnostic tests that depend on radioisotope localization (ab), April, 623
- WILLIAMS, WILLIAM L., STONER, RICHARD D., and HALE, WILLIAM M.: Correlation of early radiation changes in lymphatic tissues with antitoxin-producing ability (ab), April, 636
- WILLIAMSON, EARLE W. See DeAMICIS, EGILDA
- WILLIS, THAYER. See DAUZIER, GEORGES
- WILLSON, JAMES K. V. See McAFEE, JOHN G.
- WILMS' TUMOR. See Kidneys, tumors
- WILNER, DANIEL. See SHERMAN, ROBERT S.
- WILSON, JOHN K. See MACPHERSON, JOHN
- WILSON, T. G.: Note on congenital laryngeal stridor (ab), April, 601
- WILTSE, LEON L., and FRANTZ, CHARLES H.: Non-suppurative osteitis pubis in the female (ab), April, 613
- WINSTEN, JOSEPH, GOULD, DAVID M., and WARD, GRANT E.: Sialography (ab), Jan., 123
- WINTER, CHESTER C.: A clinical study of a new renal function test: the radioactive Diodrast renogram (ab), June, 903
- WINTROBE, M. M. See BUSH, J. A.
- WISE, BURTON L.: Angiographic demonstration of the primitive trigeminal artery (carotid-basilar anastomosis), May, 731
- WISE, ROBERT E., and O'BRIEN, RICHARD G.: Interpretation of the intravenous cholangiogram (ab), Jan., 135
- JOHNSTON, DAVID O., and SALZMAN, FERDINAND A.: Intravenous cholangiographic diagnosis of partial obstruction of the common bile duct, April, 507
- WISOFF, CARL P., and FELSON, BENJAMIN: A comparative study of the newer contrast media used in cholecystography and cholangiography (ab), May, 774
- WISSLER, H.: Non-specific spondylitis in children (ab), April, 612
- DE WITTE, F.: Osteomyelitis and sarcoma (ab), Jan., 139
- WOHL, GEORGE T.: Vertebral metastasis in renal carcinoma: an anatomic correlation (ab), March, 454
- See GARRITANO, ANTHONY P.
- WOLFF, AAGE. See JENSEN, VIDAR
- WOLMAN, M. See ABRAMOV, A.
- WOODRUFF, J. H., Jr., CHALEK, C. C., OTTOMAN, R. E., and WILK, S. P.: Roentgen diagnosis of renal neoplasms (ab), Feb., 500
- WOODRUFF, P. S.: Mass surveys for tuberculosis (ab), Feb., 282
- WOOLF, WILLIAM E. See JUNIPER, KERRISON, Jr.
- WORDEN, JAMES P. See WEISSMAN, IRVING
- WORINGER, E., LANGS, A., BRAUN, J. P., and BAUMGARTNER, J.: Serial angiographic study of the circulatory dynamics of the brain (ab), May, 756
- WOUNDS
—medical care of wounds contaminated with radioactive materials (ab), Asher J. Finkel and Earl A. Hathaway, March, 476
- WRIGHT, KENNETH A. See HICKS, SAMUEL P.
- WRIST
—fractures of triquetrum (ab), Noel F. Bartone and R. Vincent Grieco, Feb., 297
- WYNN-WILLIAMS, A. See STEWART, A. M.

X-Y-Z

XANTHOMA

—radiotherapy of xanthomatous giant-cell tumors (ab), Sven Hultberg and V. Belloch Zimmermann, June, 909

XANTHOMATOSIS

—generalized xanthomatosis with calcified adrenals (ab), A. Abramov et al, Jan., 142

YALOW, ROSALYN S., and BERSON, SOLOMON A.: Disulfide reduction and release of iodide 131 following irradiation of 131 labeled proteins, Jan., 100

Some applications of isotope dilution techniques (ab), April, 624

YIANNAKOPOULOS, APOSTOLOS. See WACHSMANN, FELIX

YOUNGBLOOD, VERNON H., WILLIAMS, JEROME O., and TUGGLE, ALLAN: Reactions due to intravenous Urokon (ab), April, 617

YTTRIUM, RADIOACTIVE. See Radioactivity, radioyttrium

YUAN, R. H. P. See SELVERSTONE, B.

ZAINO, COSTANTINO, and POPPEL, MAXWELL H.: Acquired hiatus hernia (ab), March, 451

—See POPPEL, MAXWELL H.

ZARKIN T., MOISES. See GARCIA CASTAÑEDA, MÁXIMO

ZATUCHNI, JACOB. See SOLOFF, LOUIS A.

ZDANSKY, E.: Focal carcinizing necrotizing pneumonia and its differentiation from carcinoma of the bronchus (ab), May, 763

ZEIER, FRANCIS G. See KERNWEIN, GRAHAM A.

ZEITEL, BERTRAM E. See LENTINO, WALTER

ZELIGMAN, ISRAEL. See McMULLAN, FRANCIS H.

ZENDLE, B., KOCH, H. W., McELHINNEY, J., and BOAG, J. W.: Studies of dose distributions in water for betatron x-rays up to 37 Mev (ab), June, 910

ZGODA, ADAM. See ARENDT, JULIAN

ZIEVE, LESLIE, VOGEL, WILLIAM C., and SCHULTZ, ALVIN L.: Determination of protein-bound radioiodine with an anion exchange resin (ab), March, 469

ZIMMER, JAMES F., DAHLIN, DAVID C., PUGH, DAVID G., and CLAGETT, O. THERON: Fibrous dysplasia of bone: analysis of 15 cases of surgically verified costal fibrous dysplasia (ab), Feb., 253

ZIMMERMAN, H. M. See NETSKY, MARTIN G.

ZINN, BERKELEY, and MONROE, JAMES: The lordotic position in fluoroscopy and roentgenography of the chest (ab), Feb., 280

ZION, M. M.: Mitral stenosis associated with anomalous pulmonary venous drainage into a left superior vena cava (ab), March, 441

ZIRCONIUM
—study of effects on lung of industrial exposure to zirconium dusts (ab), C. E. Reed, May, 764

ZSEBÖK, Z. See GERGELY, R.

ZUCHERMAN, SIDNEY D. See JACOBSON, GEORGE

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